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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

A TENTATIVE THEORY OF THERMO-ELECTRIC ACTION.*

LET the lines (1)–(1) and (2)–(2) in Fig. 1 be the lines representative respectively, of two metals M_1 and M_2 in the ordinary thermo-electric diagram. We may, if we please, think of these metals as copper and iron, respectively. The lowest horizontal line is the temperature coordinate and begins at the absolute zero.

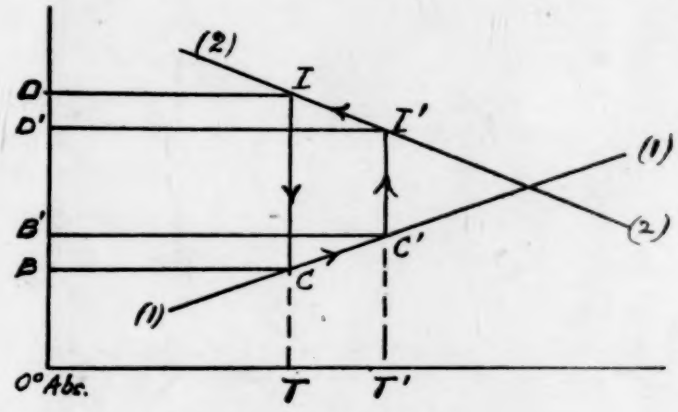

FIG. 1.

The diagram is so constructed that the area $CC'I'IC$ is equal to the net thermo-electromotive force, E, counterclockwise, in the circuit indicated by Fig. 2, in which the left-hand junction is kept at temperature T and the right-hand junction at temperature T'. We will suppose that E is expressed in mechanical units, as the

* Address of the vice-president and chairman of Section B—Physics, American Association for the Advancement of Science, Philadelphia, December, 1904. [The theory here given is certainly incomplete, and I fear that it is not entirely self-consistent. It is intended to be suggestive rather than conclusive or exhaustive.—E. H. H.]

amount of work done, at the expense of heat, on unit quantity of electricity while it goes once around the circuit. Evidently, then, the area $CC'I'IC$, which represents E, represents also the mechanical equivalent of the net amount of heat consumed by unit quantity of electricity in one cycle.

Fig. 2.

The arrow-points in Fig. 1 indicate merely the direction of the current resulting from the net E of the circuit.

It is consistent with what precedes to consider the area $BCC'B'B$ as representing that part of the total, or net, E which lies in the unequally heated M_1 between T and T', the area $B'C'I'D'B'$, as representing that part of E which lies in the junction M_1-M_2 at T', etc.; and this interpretation is sometimes given as a mere statement of fact. In the course of this paper it will, I hope, be shown that another view of the matter is consistent with the known facts of the case.

As this declaration puts me for the moment into a somewhat heretical attitude, let me hasten to say that I hold as strongly as any one to the proposition that the area $BCC'B'B$ represents the amount of heat absorbed by unit quantity of electricity in going through the metal M_1 from the temperature T to the temperature T', that the area $B'C'I'D'B'$ represents the heat absorbed by unit quantity of electricity in going from M_1 to M_2 at temperature T', etc. This proposition is familiar and needs no proof from me; but I wish to develop a little one aspect of it which is sometimes overlooked, an aspect which has a decided pedagogic value and which is at least suggestive of the line of thought I wish to follow later.

As we have in Fig. 1 a diagram in which areas represent heat absorbed, and in which one of the coordinate axes represents temperature, the other axis must represent entropy. Let us, therefore, in order to conform to the common practise in the use of the temperature-entropy diagram, make the T axis vertical, and the entropy, or S, axis horizontal, thus getting as the equivalent of Fig. 1 the Fig. 3.

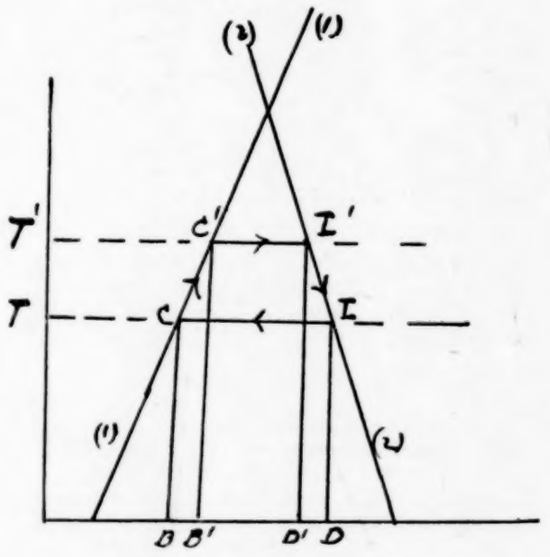

Fig. 3.

It is to be observed that Fig. 3 is the obverse of Fig. 1 so that the arrow points, without any relative change of position in going from one figure to the other, now lead clockwise around the area $CC'I'IC$.

Any one who is familiar with the temperature-entropy diagram of the steam-boiler-engine cycle, as given and discussed by Ewing, will see at once interesting points of resemblance between Fig. 3 and that diagram. For example, the sloping line CC', which indicates one phase of the Thomson effect, the absorption of heat by the electric current in passing through the metal M_1 from a point at temperature T to a point at the highest temperature, T',

is analogous to the sloping line which in the steam-boiler-engine diagram indicates the absorption of heat by the feed water from the condenser in mixing with the hot water in the boiler. The slope of each line implies that the working agent, electricity in one case and water in the other, takes in the particular quantity of heat represented by the area under the line at a temperature below the highest of the cycle, and therefore, does not make the best possible thermodynamic use of the heat supplied and of the range of temperature available. Similarly the inclined line $I'I$, which indicates that heat is absorbed by the electric current in passing through the metal M_2, from temperature T' to the lower temperature T, is analogous to the line of the steam cycle which indicates the recovery of heat from the cylinder wall during expansion after cut-off.

Furthermore, the horizontal lines $C'I'$ and IC, indicating the absorption or emission of heat by the electric current in passing, without change of temperature, from one metal to the other, are analogous to those horizontal lines of the steam cycle which indicate absorption or emission of heat in the act of evaporation or of condensation. To this analogy we shall presently return.

Let us for the moment occupy ourselves with a reexamination of the prevailing opinion as to the relation between the heat absorption or emission at the junction of two metals and the difference of potential, or the electromotive force, at that junction, that is, between the thermal aspect and the electrical aspect of the Peltier effect. We shall find the situation not quite so clear as it is often supposed to be.

Maxwell* states that the amount of heat taken up or given out by unit quantity of electricity in going from one metal to another at any temperature is a measure of 'the electromotive contact force at the junction'; and he says that 'this application * * * of the dynamical theory of heat to the determination of a local electromotive force' is due to Sir Wm. Thomson.* He then goes on to declare that—"The electromotive force at the junction of two metals, as determined by this method, does not account for Volta's electromotive force. * * * The latter is in general far greater than that of this article, and is sometimes of opposite sign," etc.

But it is a remarkable fact that Thomson, years after he had pointed out the method which Maxwell approves for determining contact electromotive force, came out (in 1862) with a letter giving a 'New Proof of Contact Electricity,' his famous 'divided ring' experiment, in which letter he says "For nearly two years I have felt quite sure that the proper explanation of voltaic action in the common voltaic arrangement is very nearly Volta's," etc.

I do not feel called upon to take up the cudgels for Thomson or for Volta. The point of immediate interest is that Thomson, after proposing the thermodynamic method of determining contact electromotive force, found it possible to hold a view contradictory to the soundness of this method. This fact may give the rest of us courage to question the finality even of Maxwell's opinion as to the relation between electromotive force and heat in the Peltier effect. I believe, too, that Poincaré, in article 292 of his 'Thermodynamique,' holds that the opinion supported by Maxwell may be wrong. Let us see what we can do with the question thus raised.

By *difference of potential*, $D_{2.1}$, between two points I shall mean the net amount of work which must be done because of the attractions and repulsions of electric charges (to use the convenient terms of

* 'Electricity and Magnetism,' § 249.

* *Proc. Roy. Soc. Edin.*, Dec. 15, 1851; *Trans. Roy. Soc. Edin.*, 1854.

action at a distance) in carrying unit quantity of positive electricity from point 1 to point 2.

By *electromotive force*, $E_{1.2}$, along a given path from the point 1 to the point 2, I shall mean

$$E_{1.2} = D_{2.1} + i_{1.2}R_{1.2},$$

where $i_{1.2}$ is the current from (1) to (2) and $R_{1.2}$ is the resistance of the chosen path from (1) to (2).

If either i or R is zero,

$$E_{1.2} = D_{2.1},$$

which is practically the case when we have a battery in open circuit, (1) being one terminal and (2) the other, or when we have under consideration two points on opposite sides of a junction of two metals, but exceedingly near together, even if a current is flowing from one to the other.

We have already, looking at Fig. 3, compared the passage of electricity from metal 1 to metal 2 to the evaporation of water in a boiler. Now in this evaporation work of two kinds is done upon the water, internal work and external work. The movement of electricity across a junction against a difference of potential corresponds to the external work of evaporation. Is there accompanying this movement anything corresponding to the internal work of evaporation? If so, the heat absorbed by the electricity in the movement may be as bad a measure for the difference of potential at the junction as the latent heat of evaporation would be for the external work of evaporation.

It is not absurd to imagine that there may be some change of state of electricity besides change of potential. It is possible that we should take account of something like an attraction between electricity and the metals with which it is associated. Helmholtz imagined such an attraction in order to explain the action of a galvanic cell. Indeed, we are familiar with the idea that attraction or repulsion exerted on the electric charge which ordinary matter may bear is communicated to the matter itself. When the charge on a pith ball is drawn this way or that, it carries the pith ball along with it. To be sure, this phenomenon and others like it may not indicate any fundamental attraction between ordinary matter and electricity. Perhaps they can all be explained by stresses in the dielectric surrounding or penetrating the ordinary matter; but whatever the true agencies may be, they at least simulate attraction or some physical tie between ordinary matter and electricity. We may, therefore, feel free to make speculative use of such attraction.

Our problem is to find, if we can, by use of any reasonable hypothesis, an explanation of the way in which heat drives an electric current around the circuit of dissimilar metals unequally heated.

There are two types of mechanical circuits or cycles operated by heat with which we are very familiar, the steam-boiler-engine cycle, in which the circulation may be practically in a horizontal plane, and various convection cycles, commonly used for heating and ventilation, which may be in vertical planes. In the horizontal cycle we must have valves. Circulation is secured by heating or cooling a fluid which is free to expand or to contract on one side, but not on the other side, the valves being so contrived as to give the necessary freedom and the necessary restriction. In the convection cycle we do not necessarily make use of valves. If the heating and cooling are effected at the right parts of the circuit, gravity supplies the differential force necessary to maintain circulation.

How can the metals of our thermo-electric circuit take the function of valves or the function of gravitation and so determine the flow of electricity at the expense of heat energy?

Let us consider first the case of a thermo-electric couple in which neither metal has any Thomson effect, but in which there is a tendency of positive electricity from (1) to (2) at each junction. The thermo-electric force of such a circuit can be accounted for by assuming that metal 2 attracts positive electricity more and negative electricity less than metal 1, and that both these differential attractions increase or decrease with change of temperature of the *electricity*.

At first glance one is likely to think that the differential forces here imagined must increase with rise of temperature, as it may at first seem that the forces at the hot junction must prevail over the opposing forces at the cold junction. But this need not be. The action must be such as to *take in heat at the hot junction* and to *give out heat at the cold junction;* but this condition is perfectly consistent with the prevailing of the attractive forces at the cold junction.

For, consider the analogous case of circulation of water in a pipe circuit made up of two verticals and two horizontals (see Fig. 5). If heat is applied at the proper part of one vertical and if heat is taken away from the proper part of the other vertical, the water will ascend against the force of gravity at the heated place and descend under the pull of gravity at the cooled place. That is, the attractive force, upon the differential action of which the circulation depends, prevails at the place where heat is taken out from the system.

Another analogous case is that of two galvanic cells of precisely the same kind, one cold and the other warm, set to work in opposition to each other. If the cells are such that each would grow warm (aside from the development of resistance heat within its parts) by its own direct action, the cooler cell will prevail, and *vice versa*.

So, if the spontaneous action at each junction of our two metals, if each junction could have its own way, would be such as to generate heat at the junction, the cooler junction will prevail when the two are opposed, and *vice versa*.

Now we have rather more reason for expecting, in a given untried case, that the free action of attractive forces will generate heat than we have for expecting that it will absorb heat. Consider, for example, the heat freed as the result of molecular attractions in the condensation of a vapor. Accordingly, if we are to account for a thermo-electric current, in such a combination of metals as we have imagined, by attraction of ordinary matter for electricity, this attraction varying with the temperature of the electricity, we are naturally led to the opinion that the colder junction prevails.

The assumption of such an attraction as we have here imagined, with its dependence on the temperature of the electricity and its independence of the temperature of the metal, except as the temperature of the metal determines that of the electricity within it, is much less violent than it at first appears. If there is such a phenomenon as the expansion of electricity, that is, a diminution of general volume density of electricity, with rise of temperature of the metal containing it, corresponding to the expansion of air or water in the heated part of a convection circuit, this is enough to give just the temperature relation required. For, the lessened volume density of the electricity at the hot junction of the two metals would imply a diminished tendency of the electricity to pass over to the more strongly attracting metal at that junction; but just as there is no tendency of water to flow by gravitation along an unequally heated pipe, if this pipe is horizontal, so there would be no tendency for electricity to flow along an unequally heat-

ed homogeneous metal bar, unless the hot parts of this bar attracted a given quantity of electricity more or less strongly than the cold parts. The two metals in which we have stipulated that there shall be no Thomson effect correspond in our thermo-electric circuit to the horizontal pipes of our imagined convection system; and for the comparison which we are here making it is well to go back to the usual disposition of the thermo-electric diagram, in which unequally heated metals having no Thomson effect are represented by horizontal lines.

Let us now consider a case in which the Thomson effect does play a part, such a case as that illustrated by Figs. 1 and 3. We can, apparently, account for the Thomson effect in any metal by assuming that this metal has a greater attraction for electricity of one sign than for electricity of the opposite sign, and that the difference of these attractions is a function of the temperature of the *metal*. With this condition the electricity of one sign at any part of a homogeneous but unequally heated metal bar will be subject to a net attraction, exerted by the metal, toward a place of higher temperature or toward one of lower temperature, according as the attraction between the metal and this kind of electricity increases or decreases with rise of temperature of the metal; and the other kind of electricity will be subject to a different, greater or less, net attraction from the metal; so that a difference of potential would be set up between the hot and cold part of the bar, if the bar were left to itself.

If we take the view that the electromotive forces which prevail are those at places where heat is given out, we shall in Fig. 3 have the local electromotive force, due to the attraction between metal and electricity, opposite at every place to the electromotive force commonly supposed to reside at that place; so that the unequally heated metals and the hot junction will still conspire against the cold junction; but, as the direction of the current is known by experiment to be that which is indicated by the arrow points in Fig. 3, we must in this case suppose that *the cold junction prevails over the opposing combination.*

Let us now consider the magnitude of the local electromotive forces. In any case the net electromotive force of the whole circuit is expressed, as we agreed at the beginning, by the area *CC'I'IC* of Fig. 1 or Fig. 3. But knowledge of the net electromotive force of the circuit tells us little or nothing of the magnitude of the individual four electromotive forces of the circuit. Ordinary doctrine represents these by the areas, already mentioned, under the lines *CC', C'I',* etc., in Fig. 3, down to the line of absolute zero of temperature, but as we now undertake to have the electromotive force at the cold junction prevail over the other three, it is evident that we must look for other areas on the thermo-electric diagram to represent these local forces. In this case we find such areas *above* the lines *CC', C'I',* etc., in Fig. 3, or in Fig. 4, which we will now use in place

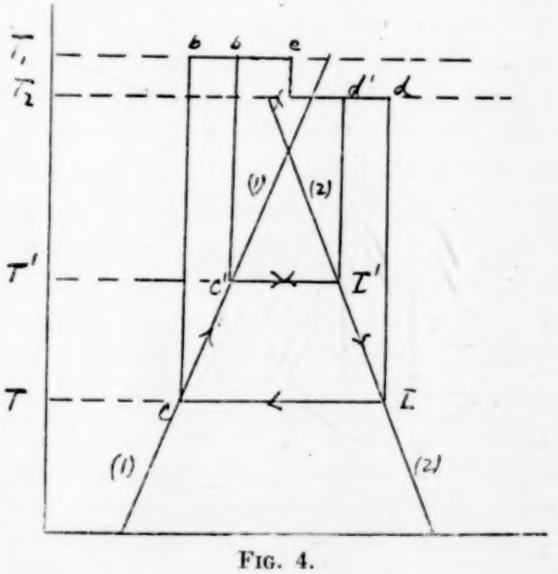

Fig. 4.

of Fig. 3. Thus the area *Cbb'C'C*, terminated above by the temperature line T_1, characteristic of metal 1, may represent the thermo-electromotive force directed from C' to C in the unequally heated (1).

Similarly the area *I'd'dII'*, terminated above by the temperature line T_2, characteristic of metal 2, may represent the thermo-electromotive force directed from I to I' in the unequally heated (2).* The area *C'b'efd'I'C'*, terminated above by the broken line *b'efd'*, depending on both T_1 and T_2, may represent the thermo-electromotive force directed from I' to C' at the hot junction. Finally the area *Cbb'efd'dIC*, terminated above the broken line *bb'efd'd*, depending on both T_1 and T_2, may represent the thermo-electromotive force directed from I to C at the cold junction. This last, larger than the sum of the others, which oppose it, would be the prevailing electromotive force. The net electromotive force of the circuit would be, as in Fig. 3, represented by the area *CC'I'IC*, and the current would run, as before, clockwise with respect to the boundary of this area.

We have apparently succeeded in accounting for the circulation of the electricity by means of differential attractions conditioned by differences of temperature and in showing that the local electromotive forces of the thermo-electric circuit may be opposite in direction to those which are commonly supposed to exist. But we have as yet given no conclusive reason why heat should go in at one part and out at the other, and we have not yet made any attempt to show how heat is used up in the circuit. Our explanation, so far as it has now gone, utilizes difference of temperature but does not utilize heat.

If we return to the consideration of our analogical convection system, we see that, if we were to put in heat at any point p only and take out heat at the point p' only, these two points being on the same level, there would be no continued circulation, as we should presently have the fluid at a uniform temperature all the way over from

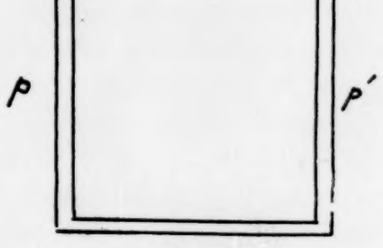

FIG. 5.

p to p' and at a uniform, though different, temperature all the way under from p' to p. To maintain circulation we must have the point p, at which heat enters, at a lower level, and therefore at a higher pressure, than the level and the pressure of the point p', at which heat comes out. The work and the absorption of heat at expansion under high pressure would be greater than the return work and the emission of heat at the lower pressure, and the difference between the inflow and the outflow of heat would be utilized in maintaining circulation against some resistance.

Do we naturally find anything in our thermo-electric circuit corresponding to this heat differential?

We have already assumed that the electricity within each metal acts like an expansible fluid, and it is natural to assume that the rise of temperature which causes the expansion of the electricity absorbs heat. That is, we naturally assume next that there is a real thermal capacity of

* T_1 is apparently the temperature at which the differential attraction of M_1 for the two kinds of electricity becomes zero. A like explanation holds for T_2. [The sloping lines might curve so as to strike the lines T_1 and T_2, respectively, at any angle.]

electricity, or of the corpuscles moving with it, which would come to the same thing. Moreover, we can hardly avoid supposing that the attraction which we have assumed to exist between metal and electricity holds the electricity within the metal in a state of pressure; and accordingly we must recognize in the thermal capacity of the electricity a part accomplished against this pressure in the expansion which accompanies rise of temperature.

Returning, with these additional ideas, to the examination of a thermo-electric circuit showing no Thomson effect, we find that we must in such a case suppose that in each metal the heat absorbed by the current of electricity, positive or negative, which is flowing from cold to warm within that metal is balanced by the heat given out by the current of opposite sign, negative or positive, which is flowing in equal strength from hot to cold within the same metal.

But at the junctions the case is different. At the junction which is the prevailing one, across which each kind of electricity flows from the metal by which its kind is attracted less to the metal by which its kind is attracted more, that is, from a place where the pressure caused by the attraction is less to a place where the pressure caused by attraction is more, each kind of electricity will, without change of temperature, suffer contraction of volume in the transition, and evolution of heat will result. On the other hand, at the other junction, where each kind of electricity moves, without change of temperature, from a place of high attractive pressure to a place of low attractive pressure, each kind will expand in the transit, and absorption of heat will accompany this expansion.

Thermodynamic considerations show us that in such a case as that which we are considering, in which there is no Thomson effect, heat must be taken in at the hot junction and heat must be given out at the cold junction. Hence our theory, with its later assumptions, assumptions suggested, as others have been, by reflection on the manner and reason of the working of an ordinary convection cycle, has led us clearly to the conclusion that the cold junction should be, in the case considered, the prevailing junction. But thermodynamic considerations go further. They require that the amount of heat, Q', taken in at the hot junction at temperature T', must bear to the heat, Q, given out at the cold junction at temperature T, such a relation that

$$\frac{Q'}{T'} = \frac{Q}{T}.$$

Can we without a straining extension of our assumptions meet this condition? Apparently we can do so by supposing that electricity in its state of compression within each metal obeys the law of a perfect gas. At the hot junction we have the positive electricity going, at constant temperature T', from the attractive pressure p to the attractive pressure $p - dp$, with consequent expansion, work of expansion, W', and absorption of heat equivalent to this amount of work. At the cold junction we have the positive electricity going, at constant temperature T, from the attractive pressure $p - dp$ to the attractive pressure p, with consequent compression, work of compression, W, and evolution of heat equivalent to this amount of work. From the gas law, $pv = KT$, we have, when T is constant,

$$pdv = -vdp = -\frac{KT}{p}dp.$$

This gives us, since p and dp are the same at the hot junction as at the cold junction,

$$W' : W :: pdv' : pdv :: T' : T.$$

And so

$$Q' : Q :: T' : T.$$

The production of absorption of heat within a single unequally heated metal, the calorimetric aspect of the Thomson effect, is, apparently, easily accounted for without additional assumptions. Thus, according to the theory already stated, the line *CC'* in Fig. 4 represents a case in which the attractive pressure of the positive electricity is greater at the cold end than at the warm end, while the attractive pressure of the negative electricity is greater at the warm end than at the cold end, of metal 1. According, positive electricity moving from the cold end to the warm end of this metal will expand more, and therefore absorb more heat, than the mere rise of temperature requires, while the negative electricity in moving from hot to cold within the same metal will contract less, and therefore give out less heat, than the mere fall of temperature requires. That is, to use the conventional mode of expression, the current absorbs heat where it flows from cold to hot in metal 1. For the line *II'* and the metal 2 the case is *vice versa*.

The conception of electricity, each kind of electricity, as acting within a metal like a perfect gas seems very revolutionary to one who has been strongly impressed by Maxwell's discussion of the analogy which the behavior of electricity in Faraday's 'ice-pail' experiment presents to the behavior of an 'incompressible fluid,' though Maxwell in pointing out this analogy warns us against being too much influenced by it.

The ice-pail experiment, however, as I understand it, proves merely the difficulty in putting an appreciable excess of either kind of electricity into a given space, a difficulty which still exists after all the assumptions of this paper are made. Consider, for example, the difficulty of putting any considerable excess of positive or of negative ions into an electrolyte. Indeed, the idea of the electric current within a solid as consisting of two oppositely moving perfect gases is so like the familiar and commonly accepted idea of the current in an electrolyte, where we apparently have two oppositely moving bodies of ions, each body obeying the gas law in its osmotic pressure, that, instead of being troubled by the heretical character of this view of the current in a solid, I am somewhat concerned lest I am failing to give due credit to some one who has already proposed it. Of course, Drude in his electron theory does apply the gas laws in some particulars to the electrons within metals, and I can not be sure that he has not anticipated me in much that is given in this paper, though I did not, so far as I am aware, get from him any of the main features of the theory here proposed.

The question naturally arises, Why not determine the direction and magnitude of the local electromotive forces of the thermo-electric circuit, and so get a decisive trial of the case between the ordinary and the proposed view of thermo-electric action? The reply is that physicists have been trying for more than a hundred years to get a satisfactory determination of a single one of these local forces, the one measured by the true contact difference of potential between any two metals, and have, apparently, not yet succeeded in the attempt. It is the old question of the Volta effect. Some months ago I was of the opinion that Mr. John Brown, F.R.S., of Belfast, had found a way of getting rid of the disturbing effect of the medium surrounding the two metals, zinc and copper in his case, by heating them for several hours in a certain kind of oil. Considerable recent experience with various kinds of oil at the Harvard Physical Laboratory has led me quite unwillingly to the conclusion that the kind of treatment to which Mr. Brown subjects his metal plates may substitute for the disturbing surface condition acquired in air an equally baffling surface

condition produced by the action of the oil.

An attempt to measure directly the difference of potential between the two ends of an isolated unequally heated bar of metal would, apparently, encounter obstacles quite as great as those which have thus far proven unsurmountable in the case of attempts to measure directly the contact difference of potential between metals. The outlook is, therefore, not bright for any immediate and final answer, on experimental grounds, to this question of the direction and magnitude of the local electromotive forces with which we have been dealing.

I wish to add one afterthought. If electricity flows like a perfect gas through a homogeneous solid conductor of uniform cross-section, its velocity at any given cross-section of the conductor must be, approximately at least, proportional to the absolute temperature of this cross-section. Now the ordinary law of resistance in the case of a fluid moving through small passages is this: Resistance is proportional to the velocity. Accordingly, we are led to the conclusion that the resistance encountered by our electric stream should be proportional to its velocity, that is, other things being equal, proportional to the absolute temperature at the part of the conductor considered. Now we know that in pure metals this is the general law of resistance, and the fact that this law finds an explanation in a conception of the electric current formed without any reference to electrical resistance adds considerable weight to the argument in favor of that conception.

Edwin H. Hall.

Harvard University.

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*THE ALAMOGORDO DESERT.**

The Alamogordo desert of southern New Mexico lies immediately west of the 106th meridian, west, and approximately between thirty-two and thirty-four, north. It is bounded on the north by the Oscuro range of mountains, on the east by the Sacramentos, on the south by the Jarillas and the Organ mountains, on the west by the San Andreas. As here defined, therefore, the desert is of comparatively limited area, one hundred or one hundred and twenty-five miles from north to south, and perhaps thirty-five to fifty from east to west; a very convenient little desert, easily manageable, one might suppose, for any naturalist, who, with inborn love of adventure, starts out in search of the wilderness to find scenes and pastures new.

A year ago in this presence, it may be recalled, the present speaker, by aid of photographic illustrations, attempted to sketch the relations obtaining, as would appear, between the geology of the desert and its flora; in the present paper it is intended briefly to resume the earlier argument with such added reflections as may be suggested by present conditions and by recent renewed acquaintance with the problem.

The desert of Alamogordo or Tularosa is a great plain, not unmarked, however, by singular topographic inequalities later on to be described. Only the most casual geologic examination is sufficient to show that the plain floor corresponds stratigraphically with the beds in some places exposed at or near the tops of the surrounding mountains, in any case far up their flanks. On the east especially limestones of carboniferous age rise sheer some 1,000 feet or more straight up from the desert floor, and are again capped by other strata only at length, perhaps 1,000 feet higher, surmounted by materials correspondent with those in the level of the plain.

On the west the same thing is true; but more emphasized still is the difference in

* Address by the vice-president and chairman of Section G for 1904. Philadelphia, Pa.

level between segments of corresponding strata. Here the weird Organ mountains break the horizon by upthrust spires and pinnacles of granite which to some early voyageur crossing these dusty plains suggested the pipes and architecture of some far-off organ, and the mountains were so named; but upturned granite means that the sedimentary rocks are here further uplifted still than on the eastern side, so that we quickly find ourselves in presence of vast parallel faults and our desert lies thus between their giant walls. It is as if half the region between this city and New York should suddenly sink two or three thousand feet, or what is the same thing, it is as if the several thousand feet of difference in level were brought about by the depression of the included area, and the simultaneous elevation of the sides. At any rate, the desert plain of the Alamogordo or Tularosa sands is simply the upper surface of a gigantic block of the earth's crust that sank some time subsequent to the deposition of the Jura-Trias and the earlier cretaceous strata of this western world. These strata include, as we know, the famous 'red beds' which tinge the mountains of half the continent, the red beds with all their gypsums, marls and salts of every description. Accordingly, as a result of this faulting, our desert has for its foundation everywhere great fields of gypsum, often for long distances wide-exposed, sometimes thinly veiled by loosened sand, sometimes deep buried by vast deposits of wine-red marls and clays, or covered anon by the products of erosion, whether by water or by wind. The waters from the mountain snows have brought their débris; the winds of the desert have come with their burden, but nowhere has such transportation traversed the desert borders, at least in recent times; there are to-day no excurrent nor percurrent streams; the winds die along the mountain walls and the waters sink in the desiccated sands.

But this is not all. This great sunken block of earth's crust seems itself to have been cracked again and again; there are secondary faults, and along the line of one of these thinner or weaker places the subterranean energies of the world have some time found emergence. Floods of lava welled up in the midst of the desert, and fountains of fire streamed along the ground, following existent topography for miles and miles, now narrowing to dimensions measured by rods between low ranges of hills, now widening for miles across the broader valleys, only to lie at last a vast field of blackened cinder, slowly disintegrated by the desert storms. This is one of the most peculiar topographic features of the whole desert. As things terrestrial go, this is a recent phenomenon. The age of the lava may be measured by centuries, a few thousand years, it would seem, at most. The surface over which it poured was a friable, marly soil. As the floods cooled, the mass cracked and gaped in every direction. Rains descending upon the surface sank to the ground below and shaped for themselves channels. The lava so undermined has fallen into a tumbled ruin of weirdness and confusion, indescribable, impassable.

The lava constitutes one of the features of this remarkable desert; there is yet another. Along the western border, partly uncovered by erosion, partly by the western winds, great bodies of gypsum lie exposed. As this slowly disintegrates the wind gathers the particles set free and bears them eastward, the famous white sands, covering township after township with drifted mineral white as snow. Vast windrows shifting slowly with every storm, and forever reinforced by the unceasing contributions of the west, mark the landscape over several hundred square miles,

unique, intact, forever changing, yet the same forever.

Added to these peculiar and special topographic details of this surprising desert we have, of course, those less noteworthy, the common every-day features of desert make-up: we have mountain slope, rocky fields and hillsides, eroded valleys, marshy sinks, where lose themselves the vanishing torrential streams; wide plains of marly clay, belts of sand-dunes, red sands, yellow sands, also shifting and moving, but, better subservient to the vegetation of the region, these present simply vast fields of low hills or hummocks ten to twenty feet in height, separated on every side by tortuous valleys, winding in labyrinthine fashion, wind-swept, hard and bare.

One other topographic feature must yet be added to complete our picture. The forces of erosion even along the mountain walls have kept pace fairly well, at least, with the changes in level. Great cañons break back even through the hard, encrinitic limestones, dividing again and again where the waters have carved the rugged pathway by which the explorer may reach the mountain summit. The result of this erosion forms a wide talus around the desert, spreading great fan-shaped deposits at the mouth of the cañon, where immense blocks and boulders choke the exit, succeeded by ever smaller rocks and pebbles farther out, until at length only the finest silt is swept along from the widened margin far across the almost perfectly level plain.

Now it is evidently needless to say to every wisest man in an ecologically minded audience such as this, that every one of these peculiar topographic features, whether special or not, will display its own peculiar flora. True, this is not always the case; this desert must be studied in its entirety, and it will require months of patient research to even sketch its far-reaching problems. As a whole the flora may be said to be that of our western arid regions generally, and yet, after all, it is not just like that of any other region, north, south, east or west; not that it has peculiar species, perhaps, but that it has its own particular groups of species.

Two factors, and two alone, as it seems to me, determine the phytology of this desert; the one, difference in the constitution of the soil, referable to its geologic history; the other difference in level, referable to the same initiative. Thus there is a peculiar flora on the sands whether white or red; another on the silted plains less liable to transportation by the wind; another where the salts emerge, whether in briny springs and fountains or as crystals whitening the surface of the ground; another for the mountain shelves; and still another for their far-off summits.

The El Paso Northeastern Railway passes the desert on its eastern side. There are two stations on the line where for several miles in every direction the surface is a red-brown sand. One of these stations has been by the railroad people appropriately named Desert, the other is Escondida. The level of the two stations is the same, 4,000 feet, and the flora is identical, although the points are thirty miles apart. Each, however, is by itself unique and entirely separate from the other. The dominant species is *Yucca radiosa*, so much so that these points are called the yucca desert. Of course, the almost ubiquitous mesquite is there and *Atriplex canescens* and *Artemisia —— sp.?* There are other species, to be sure, such as forms of *Chrysothamnus* and *Ephedra*, but the plants first named give to the plain its character as far as vegetation goes, and in topography as well; they not only thrive here and come to abundant flower and fruit, but they hold these peculiar sands otherwise driven about the world by desert winds.

Now it is a remarkable fact that the white sands, thirty or forty miles off to the northeast, exhibit an almost identical flora. The student hastens across the intervening desert to meet that shining wall, expecting to find all things new; but, behold, the white sands are *sands* first of all rather than anything else. Whatever their chemistry, and they have their peculiar problem for the chemist, only a vegetation that can endure a moving, shifting terrene can flourish here. The white sands form, accordingly, part of the yucca desert. Their relation to vegetation is almost purely physical, but they exhibit some peculiarities. They are gypsum, as everybody knows,* but while they move as other sands, they must be compared with wet sands; the vast drifts, thirty to fifty feet in height, are *moist* often to within a few inches of the surface, and are so compactly driven that one may walk upon the solid surface with comparative ease. A white wall like to the appearance of marble is moving slowly eastward, whelming all vegetation as it goes, some of which, able to grow through the encroaching mass, persists, so that all the plants now appearing on the surface, so far as examined, are anchored by lengthened stems or roots to the underlying older soil. The same yucca that appears at Escondida here emerges sometimes by green tips from a snow-white drift twenty feet in height, or anon, seems to crown triumphantly some lower mound. The mesquite holds on, in some places a desperate fight, and certain species of *Rhus* —*R. aromatica* and *R. trilobata*, perhaps—maintain a perilous existence out over the whole region, sometimes even on the summits of the highest knolls. These sumacs are the characteristic species of the white sands.

But let us turn north. A journey of fifteen or twenty miles brings us to the black wall of the lava flow. This is a fearful region. The Mexicans call it *mal pais*, 'bad country'; giant floods whose waves are stone, fields and fissures, caverns, holes, pits and wells, alternating with tilted slopes, knife-edge culms and ridges, make a topography weird, impassable, fascinating because so unapproachable. Yet the *mal pais* is covered with vegetation. Of course, the vegetation changes, but by no means as one might easily suppose. Here is no new species, no variety of a species when the desert is studied as a whole. The change is correspondent to a change in level. The lava beds are high, and they are crowned with the flora of their own altitude. We shall meet it on the foothills of all the mountains we presently ascend. Here is no alteration of soil, for the only soil is that deposited by the wind, the lava itself being perfectly intractable. Here are the familiar mountain cedar, *Juniperus occidentalis; cholla*, sometimes twelve or fifteen feet high, where, springing in some ragged well-hole, it seems to peer out above the sooty walls that hem it in; here is the mountain barberry. Even the nut pine, *Pinus edulis*, has mistaken these pitchy steeps for the clayey flanks of its usual mountain fastness, and now and then rivals the cedar in its hold upon the jagged upturned edges of these flinty sheets. Even the lava beds have not apparently affected the general character of the desert flora.

At the south end of these black fields, however, emerge great springs. Here all the plain is saturated with salt and alkali, and here is a peculiar flora conditioned by this fact. The waters emerge almost from the edge of the lava sheets, and tufts of

* The following analysis of this material has been kindly furnished me by Dr. L. W. Andrews of the Mallinckrodt Chemical Works, St. Louis:

Calcium sulphate, $CaSO_4$	77.64	per cent.
Water, H_2O	20.55	"
Calcium carbonate, $CaCO_3$	0.95	"
Silica and undetermined, SiO_2, etc.	0.86	"
	100.00	

Suæda and *Allenrolfia* are set close against the lava wall. This is ideal; this we should expect and here it is.

The sands and the lava lie in the middle of our desert. If we take these as a starting-point and move toward the summit of the mountains, the successive belts of vegetation gradually shape themselves so that we learn presently to identify them by their color. A plain below the general level is gray, grass-covered, with here and there a bunch of *Ephedra* or nopal, no yuccas, no *Atriplex,* no other forms of cactus. As the terrene rises to the silt plain, thickets of cholla alternate with mesquite and the crucifixion thorn; not that other species do not occur, but these are dominant, give to the belt its character and color. A little further mountainward and we reach the *Covillea tridentata,* ever in bloom, which lies as a girdle of green and gold around the whole base of the mountain range, visible for miles and marking for us the limits of the talus with an exactness that is remarkable. Beyond the *Covillea* belt come the cacti as the terrene becomes more rocky; *Mamillaria,* with its species numerous and varied, the unique but widely distributed ocatillo, the prickly pear, often in giant form—all these cover the rocky slopes that lead up to the steeper walls of paleozoic rocks. Sometimes, where a shelf occurs, and the bare limestone forms a flat, mesa-like field, the yuccas come back, but not the Escondida form, with *Agave parryi,* and abundant ocatillo, while in the rocky defile below, locked amid gigantic boulders, now on their tardy journey to the talus plain, the creamy flowers and fruit of *Dasylirion* lift their glorious spikes, the envy and vexation of the photographer.

The strata of the lower carboniferous limestones now confront us; crystalline, encrinitic and exceedingly hard, rising often hundreds of feet sheer up and down. But these dry walls likewise have their flora. *Mamillaria micromeris* matches with its hoary spheres the weathered stone or lights it up betimes with scarlet bloom, and *Notholæna innata* fills with somber tufts every shattered crevice.

But the upper members of the carboniferous are much softer and, amenable to erosion, present a gentler, flowing topography. These slopes are everywhere clothed with oak, not trees indeed; far from it; low dense shrubs, the so-called shin-oak, *Quercus gambellii* and *Quercus gunnisoni.* These two species form pale green belts around the mountains, and are recognized easily, distinguishable for miles. These species indeed form a sort of phytographic border land; all below is desert; all above is forest; for above stands, or lately stood, one of the fairest bits of woodland in the United States, and that means in the world. But this forest is again in large measure conformable to geologic structure, its distribution determined by the history of what lies beneath.

As we ascend the mountain, passing all the carboniferous limestones, sands, chalk-beds and shales, we presently encounter the 'red beds' already mentioned, the most remarkable geological horizon in the country, familiar to every student of our central mountains, noted even by the ordinary tourist, the same wherever found—in Utah, Colorado, the Black Hills of South Dakota, and here again in these far-off mountains of the Mexican border, the same vast gypsum-burdened deposits of clay and shale and sand. The red beds yield easily to erosion. The washings from their wasted flanks have tinged the desert far below, and reddened the walls of every rocky cañon on the way. Sloping terraces and flat-topped hills afford a soil rocky but not infertile, supporting once more its own peculiar vegetation. Here are still the shin-oaks, it is true, but all overshadowed by other nobler trees; here is *Berberis trifolio-*

lata, the Texan barberry; here is *Pinus edulis*, Engelmann's nut pine, and most characteristic and perfect of all, here stands *Juniperus pachyphlœum*, the mountain juniper, great forests of it, ancient trees betimes, all comparatively low, but with giant trunks six or eight feet in diameter; these time-defying cedars are the trees of the red beds. With the junipers, especially as we pass their upper limits and come out upon the calcareous cretaceous swells and plains, occurs another oak or two. The soils are now remarkably rich in lime. The waters that fall on the higher mountain levels escape above the red-bed shales, but so impregnated with lime that they actually form a new stony deposit often for a distance of many rods about the point of exit. On these calcareous soils stands now the forest, along the very summit of the mountain, nine thousand feet above sea level, a magnificent forest of spruce and pine and fir: *Pseudotsuga douglasii*, the Douglas spruce, five or six feet in thickness; *Abies concolor; Pinus ponderosa* in beautiful perfection of its immortal youth; *Pinus flexilis* at its very best; a typical Oregon forest six or eight miles wide and some twenty long, crowning the summit of this isolated mountain peak in the midst of the deserts of southern New Mexico, for, as everybody knows, these are in general species of the forest of the far Pacific coast. As one stands now at last thus at the very summit of his problem, and from some promontory rock of vantage looks out upon the vast plain thus mountain-girt, the indescribable beauty of the scene must first impress him. Far to the west lie the San Andreas, the Organ and the Oscuro ranges, a long low wall, gray and solid, its serrate summits indentured in the azure sky; below, the plain, brilliantly lighted, soft and brown and lucid, save as the *mal pais* stretches its blackness as a bar sinister across the northern end, while away to the south the gypsum desert seems a cloud of snow beneath our feet, more brilliant than that evanescent whiteness that floats in the deep blue far above—the one the strange counterpart of the other; all is so silent, so changeless and so fair!

But just now we heed not the beauty of the landscape; other thoughts come crowding upon the observer, all equally insistent and impressive. Evidence of enormous physical change thrusts itself upon our astonished attention; not the sunken desert itself alone, that great block already described, but the denuded and sundered mountain walls, the great cañons that stretch back for miles, cut down through even the solid limestones at the mountain base—a process vast and old. Once the cretaceous sea rolled here, and when it retreated here were beds of limestones hundreds of feet thick. Where are they now? Only here and there a remnant on the mountain summit; the desert is covered with their débris almost to distant sea.

No less is one impressed by the slowness of all this topographic change. There is evidence of violence, suddenness, nowhere, save in the *mal pais*, which is local, recent, and does not affect the general problem. The moving currents of the air, the soft ministrations of the summer shower, the melting winter snows, have carved these mountains, are sculpturing them to-day. Those columnar whirlwinds that even now like dancing dervishes chase each other across the plain, are shaping anew the desert; that thin cloud that hangs yonder like a banner from the mountain top is a rainstorm, changing even now the general altitude of the range.

But once again; as we look out thus from the summit of our problem we are impressed with still another fact more far-reaching, more splendid still. The whole living covering of the world, the vegetative garment of the desert and the mountain,

conforms exactly to the surface, to soil and level, no doubt with an exactness that we have only begun to guess or understand. There is a mathematical line that limits the distribution of every plant, but the area forever shifts and varies. The topography varies, except the *mal pais*, by changes so slight, so delicate, as to be imperceptible to eyes unskilled, and with the topography varies its covering of life. Let us say first that these topographic changes will change the limits of distribution. Once the sands cover the silt plains, and the grasses will vanish while yucca and artemisia succeed. Widen the talus and covillea will stretch farther its golden scepter. But the problem runs far deeper than this. As the face of the world undergoes these delicate, subtle changes, the plant responds in something far more than shifting distribution. A plant, as every student of botany well knows, is the most plastic sort of an organism in the world, responding in every sort of way to its environment. We who study the microscopic structure of the humblest plants understand the limitless possibilities here. When we reflect that the suppression of a single cell at the critical moment may change the direction of the axis or alter the contour of a leaf, it is hard to set too high an estimate upon the possible response made by a simple plant to environmental variations, however delicate. We who study the physiology of the plant, peer into its changing cells and strive in imagination to reproduce the marvelously intricate reactions, physical, chemical, that forever shift and play within those narrow limits—we need not be told that every vegetable cell has in it opportunities a thousandfold to match and meet all the subtle changes suggested by the slow-creeping but implacable forces that work out the physiognomy of this time-worn earth. A little more calcium here, a little more phosphorus there, sulphates, nitrates and the rest, and the thing is done. Nay, when we even think of the form in which all energy comes from yon distant sun, and the delicate machinery on which it plays, we need seek no further occasion for the intervention of every sort of outer cosmic force. Not a tree on all the Iowa prairies but shows in its every lineament, in its very expression, a response to the Iowa environment; and so, we may be sure, every desert plant records in its present form and stature all the affirmations, all the responses it has made in all the centuries to the bidding, the silent bidding, the most gentle coaxing, of the world external. For, note you, the call for change at any given instant has not been great; the slow upheaval of these mountains, their peaceful, gentle removal by the winds and rain; that is all; but that has changed and is changing the living world. Where the terrestrial call is rude or sudden, response there is none. The lava beds show no single characteristic species. Their flora is simply that of their own rocky level. Nor could here any sudden initiative on the part of the plant avail. The adaptation is absolute now, and to vary save as the environment varies would simply invite disaster. As well the tadpole suddenly assume lungs or the lizard put on feathers.

Nor is this all—our desert as it lies shining here before us is but a fraction of that wider, vaster desert that covers all the south and west. Across the Organ and San Andreas yonder is another desert exactly comparable to that we study; all Arizona, southern California, Sonora, Chihuahua, much the same; here and there a mountain summit tufted with forest, western in type, high slopes thinly clad with stunted juniper, benches of covillea, wide low plains covered with mesquite, with yucca and cactus and all the less noble plants that stand between; and our prob-

lem widens, becomes vast as the continent, and any answer that we make must be far-reaching as the flora of a world.

Our desert lies shining here before us; but not one of these plants except the cactus is in broader sense unique; each has its kin rising in happier fields to fairer fortune. The yuccas are lilies, but lilies bloom in Bermuda and in Teneriffe, and in every most fertile garden of the world. The mesquite is a *Prosopis*, but the *Prosopis* genus shows many a handsome forest tree, and even the mesquite in the Arizona valleys, where conditions are less hard, rises a forest with trees fifty feet in height. The cactus, as I read it, with undifferentiated floral leaves and abundant sporophylls, is an ancient adaptation to an ancient desert, possibly pre-cretaceous, and takes possession of the world just so fast as the world becomes desert; unstable in cultivation, not because new, but because reversionary.

I do not mean to say necessarily that the Alamogordo desert flora has had its origin where it stands, although such a contingency is not impossible of thought. Had this been the only desert on the continent its flora is as might have been expected. But there are a hundred similar intra-montane regions whose geologic history is the same. These have in similar fashion originally shaped a flora each for itself. No doubt once similar conditions are set up in regions at first unlike, an exchange of species may take place. American cacti are at home in the deserts of Europe and the Russian thistle flourishes on Dakota plains.

The desert lies shining here before us, changing forever, but all its changes are of imperceptible delicacy and slowness. Its methods would seem not different from those by which nature has from the first essayed the education of the vegetable world. Between salt water and fresh all conditions offer by infinitesimal shadings where the rivers meet the sea, thus green plants first emerged from ocean; all conditions from shore-line low-water mark to dry land, thus the plants at length sat on the shore, wet only by tides or by the gentle rain; all conditions of level by which the plants occupy the kingdom of the upper air: all conditions of spore-union by which they meet at length the problem of aerial fertilization: so that while sports there may be among plants outside the pale of cultivation, nevertheless, they must always be within limits set as result of more gentle changes effected by the slow, and for the most part exquisitely delicate, transformations which make up the history of the planet. Given a desert flora, a cactus flora, for instance, and there may be endless species-making, by sport, if you will, or otherwise, but in every case a cactus; but the cactus itself is the child of continental movements which brought about some old-time, perhaps cretaceous desert.

Our desert lies shining before us; it is old and silent: would you know its secret, read the rocky records that lie behind, around, beneath, and be assured that once the story of yesterday were understood, the facts of to-day would ask no wider explanation. The physical forces of this world still drive the loom that weaves the web of life. Before the loom the unseen weaver sits, guiding her web that passes to an endless roll, changing withal the width, the pattern, as conditions rise. Changes her arabesque, it is for cause, changes it not, it is alike for cause; and if at intervals, as we watch, anon new figures rise, may it not be but the return of some earlier triumphant cycle that here begins anew, evident enough in cause and feature were once that giant scroll unrolled, or were her watchers more patient, more enduring. Alas! in presence of this mighty loom what fleeting, evanescent interpreters are we!

THOMAS H. MACBRIDE.

FOURTH ANNUAL MEETING OF THE AMERICAN PHILOSOPHICAL ASSOCIATION.

The fourth meeting of the American Philosophical Association was held in Philadelphia, December 28–30, 1904, attended by about sixty members. In addition to the president's address, which was delivered on the evening of the twenty-ninth by Professor Ladd on the general subject, 'The Mission of Philosophy,' and which contained an able and eloquent plea for philosophy as a comprehensive and organized *Weltanschauung*, thirty papers were either actually read or read by title at the five sessions of the meeting. Two of the sessions were of special interest, that commemorative of the centenary of the death of Kant held on the afternoon of the first day of the meeting, and the joint session with the American Psychological Association held the following morning. At the Kant session, in which the newly formed Southern Society for Philosophy and Psychology was represented by its secretary, Professor E. F. Buchner, of the University of Alabama, who read a paper, based on a careful comparison of passages, on 'Kant's Attitude towards Idealism and Realism,' one naturally looked to see what estimate American philosophers now put on the work of the most influential philosophical thinker of the past century. Five papers were read dealing with as many aspects of Kant's philosophy. The general impression which they made on the mind of at least one hearer was that, in the opinion of the most careful students, Kant is neither to be ignored, nor belittled, nor 'outflanked,' nor, on the other hand, to be unduly exalted, but to be critically studied, and that he still counts, if not as the paramount, at least as one of the most potent influences in the philosophical thinking of our time. Perhaps the widest divergence from Kant's teaching appeared in Professor Royce's paper on 'Kant's Doctrine of the Basis of Mathematics.' Royce held that the certainty of mathematical science is rightly no longer regarded as depending on constitutionally predetermined forms of perception. And yet in another respect he held Kant to have been unquestionably right, so far, namely, as he declared that constructive synthesis and observation of its ideal results are both necessary for mathematics, an insight which has profoundly influenced the progress of mathematical science. The nearest approach to a eulogy of Kant was in Professor Caldwell's paper on the 'Present Significance of Kant's Ethics.' Professor Caldwell contended that Kant's teaching had been misunderstood, and in particular that it was not open to the charge of mere formalism commonly brought against it; that the significance of Kant's ethics lay in his spiritual philosophy of human nature, a philosophy implied in all recent attempts to treat moral judgment as one of valuation, in recent epistemological assumptions about personality and in the theory of sovereignty or autonomy in the ethics of social democracy; that his emphasis on the standard as the law of personal dealing in a social realm frees us from many of the difficulties in the teleological moral philosophy of the present; and that his version of the standard is the one most consonant with a true theory of moral progress. Professor Tufts read a paper on the 'Significant and the Non-Essential in Kant's Æsthetics,' a part of his philosophy which was held to contain, perhaps, as large elements of permanent value as anything he ever wrote, and Professor G. W. Knox gave an interesting address on the 'Influence of Kant on Theology,' calling attention especially to the affinities between Kant's negative criticism of the ontological argument and the primacy he assigned to the practical reason and the theology of the school

of Ritschl. It is to be regretted that no more time was allowed for the discussion of these papers.

The first paper in the joint session with the Psychological Association, presided over by Professor W. James, was a criticism of Wundt's theory of feeling by Professor M. F. Washburn, of Vassar. The main point of the criticism was that the complexes of strain, excitement, etc., assumed by Wundt as feeling fusions really belong to an intermediate realm between sensation and feeling, and only ordinarily go unanalyzed because the organism has never needed to analyze them; but practical introspection reveals them as complexes of organic sensations. Two papers followed, one by Dr. D. S. Miller with the title, 'The Isolation of Minds,' the other by Professor Woodbridge on 'The Nature of Consciousness,' which had this in common, that consciousness, as distinct from what we are conscious of, was regarded as merely a relation of contents. But while in the one case this conception was elaborated to show that the co-experienced group of elements which constitute the contents of a consciousness at any moment had nothing in common with those belonging to any other consciousness, which latter, whether attributed to myself or another, were for the former only ejects, in the case of Professor Woodbridge it led to a suggestion of a realistic metaphysics hardly distinguishable from that which has commonly been called 'naïve.' Professor Ladd reported a case of nerve anastomosis in which the distal end of the facial nerve was united with the central end of the accessory nerve of the shoulder. By persistent efforts at voluntary control the subject was able at the end of about nine months to control the movements of the face without associated movements of the shoulder or contraction of other facial muscles. Analysis of the phenomena was held to contribute additional evidence discrediting both the idealistic and the psychophysical parallelistic theories of the relation of body and mind and confirming the theory of interaction. Professor Münsterberg gave an outline of the 'System of Values' which he is intending to elaborate in a book. The aim was to classify our absolute values and to see whether one principle controls the whole system. The values themselves were classified as validity, perfection, achievement and completeness, each relating to a particular sphere of experience and subdivided according as the value is given or created and refers to the outer world, to fellow-men or to self. The one category common to all these classes of value was found to be the category of identity. This paper, of which it is impossible to give here any but the barest suggestion, was generally felt to be the most important contribution to philosophy made at the meeting. It was so large in scope, implying, as it did, a whole system of philosophy, and so novel in matter that only the finished book itself can lead to a just appreciation of its significance, while it is certain that when the book does appear, it will provoke widespread interest and discussion.

Of the other sessions it is enough to speak briefly. At the opening session four papers were read of logical import, one by Dr. Marvin, limiting the field of epistemology to completely rationalized knowledge; one by the Rev. E. S. Steele, finding in judgment the unit of thought rather than in the idea, which was treated as only one of its elements; one by Dr. G. R. Montgomery, applying the mathematical notions of calculus to represent the mobility and functional interdependence of concepts, and one by Dr. W. H. Sheldon, defining the universal as a concrete fringe of the image or response suggesting further similar images or responses. In the afternoon

session following the joint session, Professor Dearborn read a paper on 'Consciousness in the Brutes,' in which he held that the structure and metabolism of protoplasm in general, rather than that of the nervous system, was the physical basis of consciousness. Professor J. A. Leighton, in a paper in the 'Psychological Self and the Actual Personality,' contended that psychology, neither in its structural nor in its functional analysis does justice to the actual personality, which is manifested and realized in the constructions of historical culture. Dr. William T. Harris read a characteristic paper on 'Primary and Secondary Phases of Causality,' maintaining that natural science was founded on the latter and theology on the former. The other papers put down for this session were read by title, Professor Newbold's interpretation of a passage in Aristotle relating to mental synthesis being unfortunately crowded out for lack of time.

At the closing session on the morning of the thirtieth, Dr. Woodbridge Riley read an interesting chapter from a forthcoming book on deism in America, Professor F. S. Hoffman discussed the probability for immortality, Professor H. G. Lord discussed the nature and moral character of 'Gambling as Play.' This last was something of a surprise, for after seeking to determine the nature of gambling in general and of gambling as play in particular, Professor Lord, in the second part of his paper, which was a search for some solid basis for the moral judgment of gambling as play, arrived at the conclusion that there was no justification for its almost universal condemnation, a conclusion which no one present seriously disputed. Two other papers of merit on ethical subjects were read at this session, both by members from Cornell. Dr. H. W. Wright read on 'Ethical Method,' suggesting an evolutionary interpretation of morality, moral development being treated as a process of organization unified by purposive activity, the different virtues being regarded as necessary stages in the process. Dr. T. de Laguna read an admirably clear paper on the stages in the discussion of 'Evolutionary Ethics,' of which he distinguished five, partly contemporaneous: the first being concerned with a supposed conflict between ethics and evolution; the second setting up evolutionary laws as a standard for morality; the third treating ethical problems in terms derived from the theory of organic evolution; the fourth asserting the distinctive nature of social and of specifically moral evolution; and the fifth concerned with questions of method. The last paper read was by Dr. Percy Hughes, seeking an answer to the question, Is there a distinct logic of historical construction? The answer was affirmative; it was contended that a clear perception of action as the concept of historical construction would bring about important results.

At the business meeting of the association the following officers were elected:

President—John Dewey (Columbia).
Vice-President—J. A. Leighton (Hobart).
Secretary-Treasurer—J. G. Hibben (Princeton).
Members of the Executive Committee for two years—H. N. Gardiner (Smith) and R. B. Perry (Harvard).

It was voted to hold the next meeting, at the invitation of Professor Münsterberg and the members of the Harvard Philosophical Department, at Cambridge, in connection with the inauguration of the new Emerson Hall of Philosophy, and to invite to meet with the association the Western Philosophical Association and the Southern Society for Philosophy and Psychology. A vote of thanks was passed for the hospitality accorded to the association by the University of Pennsylvania. A vote was also passed in recognition of the services of the retiring secretary. Seven new mem-

bers were elected. The association was well represented at the dinner of the naturalists and affiliated societies on the evening of the twenty-eighth, and the next night, following the president's address, an enjoyable smoker was held in conjunction with the Psychological Association.

H. N. GARDINER.

SCIENTIFIC BOOKS.

An Introduction to the Modern Theory of Equations. FLORIAN CAJORI. New York, The Macmillan Company. 1904. Pp. ix + 239. $1.75 net.

The present work falls into two nearly equal parts. The first 103 pages treat the following topics: Elementary properties and transformations of equations; location and approximation of the roots of numerical equations; solution of cubic, biquadratic, binomial and reciprocal equations; the linear and Tschirnhausian transformations. The remaining 120 pages are devoted to substitution groups and Galois's theory of the solution of algebraic equations.

The work has much that may be praised; in particular, its very moderate size, its choice of topics, copious references for further study, and a large number of illustrative examples and problems.

We mention now a few points which we believe might be improved in a later edition.

The definition of algebraic and transcendental functions in § 1 is not quite satisfactory. The author really defines *explicit* algebraic functions, and the reader might easily infer that all other functions were transcendental.

Would it not be well to give a mathematical definition of continuity of a function in § 25? The reader would then have a clearer idea of the import of the theorem of this section.

In § 26 the author assumes that a continuous function which has opposite signs in an interval must vanish in this interval. This requires demonstration unless an appeal to our intuition is allowed. If so, the demonstration the author gives, that every equation has at least one root, might well be replaced by a simpler one which rests on the property that a continuous function attains its extremes.

In § 65 the author makes use of continued fractions to prove the relation $mb - na = \pm 1$ where m, n are relative prime. It seems preferable, because more elementary, to prove this by means of the algorithm of the greatest common divisor.

In § 70 the assumption is made that numerator and denominator of a symmetric rational function are also symmetric. The definition of *incommensurable* in § 53 might be improved; we would also suggest the representation of complex numbers by points and not by vectors, as in § 22.

Let us turn now to the second half of the book which deals with Galois's theory. As the author tells us, he follows the exposition given by Weber. We must, however, in justice to Weber, note that the latter's treatment is not only more general, but is also free from a lack of precision of statement which mars the work under review and which is at times quite provoking.

The author restricts himself to equations whose coefficients are either constants or independent variables; why, we are unable to see. Certainly not because a greater simplicity is gained.

But this restriction once made, the reader should have clearly in view whether the coefficients of the equation dealt with in a given case are constant or variable. For results true when they are variable may be false when these coefficients are supposed constant. We regret to say the author is extremely careless in this important particular. Thus in chapter XI. we are informed in a footnote that the coefficients in this chapter are variables. In chapter XIII. we are left entirely in doubt; yet the theorems of Exs. 1, 2, § 119, which are used in a later chapter, may be incorrect if the coefficients are not independent variables.

This lack of explicitness is manifest in other parts of the book, *e. g.*, in the chapter on cyclic equations. The casual reader might well believe that the results established here are true for all cyclic equations. This, however, is not the intention of the author, for in

one of the examples he informs the more careful reader that a large class of equations are excluded from consideration. This is, indeed, necessary, as otherwise the reasoning of § 172 may become illusory by the vanishing of $[\omega, a]$, as simple examples will show. But even with this restriction it must be shown or assumed that this expression does not vanish.

Another point which we believe has not been sufficiently emphasized relates to the equality or inequality of rational functions of the roots. How often in Galois's theory do we have to decide whether a rational function of the roots has or has not been *changed* or *altered* by a set of substitutions. The only explanation of this fundamental and delicate matter we have found is in a footnote on page 124.

Would it not be well to restrict the term *general equation* to one whose group is the symmetric group? The author follows well-established usage in calling a general equation one whose coefficients are independent variables. Because algebraicists thought a century ago that these equations represented the general case is no reason to perpetuate a term which is sure to produce confusion in the mind of the beginner. Apropos of these equations we must express our regret that the author has allowed the demonstration given in § 158 to pass muster; it is a demonstration which does not demonstrate.

James Pierpont.

Yale University.

La contagion mentale. Dr. A. Vigouroux et Dr. P. Juquelier. Paris, 1905. Pp. 250.

This is one of the volumes in the French *Bibliothèque internationale de psychologie expérimentale, normal et pathologique.* Mental contagion is the name here given to what is generally known as imitation in the narrow sense, *i. e.*, unconscious imitation. The process is unconscious on the part of both the imitator and the person imitated. Thus contagion excludes voluntary imitation and personal suggestion. The first half of the book deals with normal contagion and the second half with abnormal.

Assuming that the reflex arc is the fundamental type of neural action, and that the impulse may enter a given sensori-motor circuit from any sense and at any point in the circuit, we may trace a physiological explanation for all the contagious acts, *e. g.*, yawning, laughing, crying, coughing, dancing, marching, etc. Then, on the theory that every emotion tends to express itself in muscular adjustment, that this adjustment may be transmitted by contagion, and that a given emotional expression creates the emotion, the same explanation accounts for the contagion of emotional states *e. g.*, fear in a panic, anger in a revolution, the soldier's adoration of Napoleon, the schools of art and the havoes of intellectual bias. The same principle may also be extended to ideas because all ideas are more or less fused with feeling, *e. g.*, belief, scientific theory, dogma. The idea is contagious in proportion to the feeling present. Good analytic and genetic accounts run parallel to this mode of explanation, and special emphasis is laid on the social conditions and significance of mental contagion. The second part of the book consists largely of citation and classification of cases. The less normal the individual or the group, the more liable to contagion. Like the microbe, the mental contagion may be either beneficent or noxious.

A practical lesson from this book is preeminent: mental contagion is preventable. If insanity and crime are contagious, that principle should be recognized in our penal and corrective institutions; and society may take steps to prevent epidemics of fanaticism and crime. To-day science is interested in the physical microbes of disease; in the near future there will be a similar interest in the facts of mental contagion.

C. E. Seashore.

University of Iowa.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Journal of Science for January contains the following articles: 'Submarine Great Canyon of the Hudson River,' by J. W. Spencer; 'Radioactivity of Underground Air,' by H. M. Dadourian; 'Types of Limb-Structure in the Triassic Ichthyosauria,'

by J. C. Merriam; 'Interaction of Hydrochloric Acid and Potassium Permanganate in the Presence of Ferric Chloride,' by J. Brown; 'Crystal Drawing,' by S. L. Penfield; '*Anemiopsis Californica* (Nutt.) H. ea A.: An Anatomical Study,' by T. Holm.

THE December number of the *Journal of Nervous and Mental Diseases* opens with an article by Dr. J. Grinker on a case of juvenile tabes in a family of neuro-syphilitics, including careful investigations of the family history, and supplemented by a report of a rather unusual case of precocious tabes without evidence of syphilitic infection, with an exceptionally long course and with fragilitas ossium. Dr. Max Schlapp and Dr. J. J. Walsh unite in presenting a case of subcortical cyst and fibroma due to trauma producing Jacksonian epilepsy, cured by operation; and the original articles for the month close with a short paper by Dr. James Burnett on the therapeutic action of veronal. The proceedings of the Boston Society of Psychiatry and Neurology, May 19, 1904, are reported, and also the proceedings of the New York Neurological Society, May 4, 1904. The 'Periscope' gives abstracts of the *Journal of Mental Science, Nouvelle Iconographie de la Salpetriere, Journal de Neurologie,* and *Archives de Neurologie.* Books reviewed are: 'Unconscious Therapeutics,' by Dr. Alfred Schofield; 'Jahresbericht über die Leistungen und Fortschritte auf dem Gebiete der Neurologie und Psychiatrie,' by E. Flateau, E. Mendel and L. Jacobson, and 'Lehrbuch der speziellen Psychiatrie für Studierende und Aerzte,' by Dr. Alexander Pilcz.

The Popular Science Monthly for January contains the following articles: 'Some Experiments of Luther Burbank,' by David Starr Jordan, giving some of the results of his labors in producing new plants; 'The Present Problems of Paleontology,' by Henry Fairfield Osborn; 'Social and Political Effects of Immigration,' by Allan McLaughlin; 'Galileo,' by Edward S. Holden; 'Radio-activity and Matter,' by the late Clemens Winkler; 'Educational Problems,' by the Lord Bishop of Hereford; some interesting facts about 'The United States Pharmacopœia,' by H. C. Wood; and 'The Mosquito Investigation in New Jersey,' by John B. Smith, which shows the very important results secured during the last three years. There are very interesting brief articles in 'The Progress of Science.'

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. ANNUAL MEETING, DECEMBER 19, 1904.

THE academy convened for the annual meeting at 7:30 P.M., on December 19, at the Hotel Endicott. The president, Professor Edmund B. Wilson, occupied the chair. A formal session for the transaction of the regular business of the academy was first held, and this was followed by a dinner at which sixty-six members and their friends were present.

The accompanying reports of the corresponding secretary, recording secretary, treasurer, librarian and editor were read and placed on file. The report of the treasurer was formally referred to the finance committee for audit.

The academy then proceeded to the election of officers for the year 1905; Professors Hovey and Lloyd were appointed tellers, ballots prepared by the council according to the provisions of the by-laws were distributed, and the votes were counted. The following officers were declared elected:

President—James F. Kemp.

Vice-Presidents—Edmund O. Hovey (Section of Geology and Mineralogy), Ernest R. von Nardroff (Section of Astronomy, Physics and Chemistry), W. M. Wheeler (Section of Biology), F. J. E. Woodbridge (Section of Anthropology and Psychology).

Corresponding Secretary—Richard E. Dodge.

Recording Secretary—Hermon C. Bumpus.

Treasurer—Charles F. Cox.

Librarian—Ralph W. Tower.

Editor—Charles Lane Poor.

Councilors (to serve three years)—Emerson McMillin and F. H. Wiggin.

Finance Committee—John H. Hinton, C. A. Post, H. F. Osborn.

The following eminent men of science were elected honorary members, being presented to

the academy for election by fellows engaged in scientific work similar to their own:

Hugo de Vries, professor of plant anatomy and physiology in the University of Amsterdam, The Netherlands. Presented by Professor Britton.

G. Johnstone Stoney, M.A., D.Sc., F.R.S., professor of natural philosophy in the late Queen's University, Dublin, Ireland. Presented by Professor R. E. Dodge.

W. C. Brögger, director of the mineralogical institute, Christiania, Norway. Presented by Professor Kemp.

Karl von der Steinen, professor of ethnology in the University of Berlin. Presented by Professor Boas.

Ferdinand Zirkel, professor of mining and geognosy in the University of Leipzig. Presented by Professor Stevenson.

Dr. Frederic A. Lucas was elected a fellow of the academy, being presented by the recording secretary.

Professor J. McKeen Cattell then proposed the health of Professor R. S. Woodward, a past-president of the academy, recently elected to the presidency of the Carnegie Institution.

The president of the academy, Professor Edmund B. Wilson, then delivered his address upon 'The Problem of Development,' at the close of which a vote of thanks was tendered to him.

The academy then adjourned.

Henry E. Crampton,
Recording Secretary.

Report of the Recording Secretary.

During the year 1904 the academy met in business session on eight occasions, and the several sections held thirty meetings, at which seventy-six stated papers and lectures were presented upon the following subjects:

	Papers.	Lectures.
Astronomy	2	1
Physics	11	
Chemistry	2	
Botany	5	
Paleontology	2	
Zoology	10	
Geology	6	
Mineralogy	2	
Physiography	2	2
Anthropology and Archeology	8	
Psychology	16	
Philosophy	6	1
Biography	1	

Particular mention must be made of the lecture upon the 'Physiography of the Alps' by Professor Albrecht Penck, an honorary member of the academy.

At present there are 278 active members, of whom 132 are fellows; the election of one fellow is pending. During the year two members have died, six have resigned, while six have been dropped on account of non-payment of dues. As five new members have been elected during the same period, there has been a net loss of nine.

In accordance with a recommendation offered by the library committee a more permanent union of the libraries of the academy and the American Museum of Natural History has been effected, to their mutual advantage. In regard to publications, it may be stated that the former method, according to which papers presented before the academy could be published in journals other than the *Annals* with the financial support of the academy has been set aside. In the future, as in earlier years, a volume of the *Annals*, to consist of three or four parts, will be issued during a calendar year.

Particular attention is now being given by the council to the matter of membership, and efforts are to be directed in the near future towards increasing the list of active members. As stated above, there has been a loss of nine during the year, although the members that resigned exceed the new members by one only. Maintenance, however, is not progressive development unless in the face of adverse conditions. The situation that confronts us is in some respects a difficult one, though not peculiar to the academy. The special societies, each dealing with some restricted branch of science, will tend more and more in the future, as they have in the past, to draw away active workers from general bodies such as the academy. Support for the academy may, therefore, be sought with a fairer prospect of success from those upon whom demands are not made by professional duties, that their activities shall be centered in the special organizations for scientific work. With such support, publication as one of our two main objects may be furthered. Efforts should

none the less be made to draw into the academy the younger men in active work, who must carry forward the activities of a scientific nature in the future, thus subserving the second purpose of the society.

One other subject of general interest must be mentioned. The council has decided that the routine work connected with the several offices of the academy shall be performed by a clerical assistant, with an office at the American Museum of Natural History, who shall be under the general supervision of the recording secretary. This arrangement provides for a still further centralization of the activities of the academy in the museum, where the library is already housed, and where the scientific meetings are now being held.

HENRY E. CRAMPTON,
Recording Secretary.

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE.

THE ninth regular meeting of the Society for Experimental Biology and Medicine was held in Professor C. A. Herter's laboratory, at 819 Madison Avenue, New York, on Wednesday evening, December 21, 1904. Dr. S. J. Meltzer presided.

Members present.—Atkinson, Auer, Burton-Opitz, Dunham, Ewing, Flexner, Gies, Herter, Jackson, Lee, Levene, Levin, Lusk, Mandel, Meltzer, Murlin, Park, Richards, Salant, Wadsworth, Wallace, Wolf.

Members elected.—John Auer, F. G. Benedict, Ludwig Hektoen, G. C. Huber, H. S. Jennings, Jacques Loeb, Leo Loeb, A. B. MacCallum, J. H. Pratt, Torald Sollmann, J. C. Torrey.

*Scientific Program.**

Radium, and some methods for its therapeutic application, with demonstrations: HUGO LIEBER. [By invitation.]

Mr. Lieber gave an interesting account of the discovery of radium by Mme. and Professor Curie, and demonstrated many radioactive phenomena. Special attention was drawn to recently discovered facts bearing on radium emanation, which show that radium discharges primarily *emanations* and *alpha rays* only, but that the emanations soon disintegrate, with the resultant production of *beta* and *gamma* rays. Because of their nearly negative penetrative power, the alpha rays as well as the emanations are practically unavailable for therapeutic purposes when the radium is used in glass tubes or in similar containers.

Various observers have noted beneficial therapeutic effects of radium, especially on diseased tissues, as in cancer. Germicidal results have also been obtained. On the other hand numerous therapeutic failures have been recorded. The author believes that in all probability many of these disappointments have ensued solely because the practitioner has not had available, in such cases, just those radiations of radium which are required for therapeutic effects.

This opinion of past therapeutic failures led the author to conduct some experiments designed to discover a method of applying radium more advantageously. Such a method seemed to require (*a*) a disposition of the radium in *very thin layers*, so as to yield the maximum proportions of alpha rays and emanations, and (*b*) its application in a container *permeable by the rays and the emanations.* These experiments finally led to the production of what the author terms '*radium coatings.*'

The preparation of the coatings may be illustrated by their application to celluloid rods. The radium salt is dissolved in a solvent such as alcohol. The rod is then dipped into this solution. On its withdrawal, the radium solution adherent to the rod quickly evaporates, when the radium is deposited in a very thin layer. The celluloid is somewhat softened temporarily by the alcohol, a fact favoring superficial incorporation of the radium. Accidental removal of the radium may be effectually prevented by dipping the radium-coated rod into a proper collodion solution, quickly withdrawing it, and

* The abstracts presented in this account of the proceedings have been greatly condensed from abstracts given to the secretary by the authors themselves. The latter abstracts of the reports may be found in current issues of *American Medicine* and *Medical News.*

allowing the collodion to deposit in a thin film by evaporation. An anilin dye, when added to the radium and collodion solutions, shows the exact situation and extent of the coating.

The thin collodion covering is permeable to both the alpha rays and the emanations. Such coatings produce beautiful scintillations, on zinc sulfid screens. Very small areas, such as the tips of delicate rods, coated in the manner described, compare very favorably in discharging the electroscope, with 1 gram preparations of radium bromid of 10,000 activity *in glass tubes,* or with 10 milligram preparations of radium bromid of 1,000,000 activity in *thin aluminium tubes.* When air is blown over the radium coatings the air carrying the emanations discharges the electroscope. These facts were demonstrated by the author.

The radium coatings make it possible to apply radium directly to practically every part of the body. The radium thus applied would be practically equivalent in radioactive effects to the same amount of uncovered radium in a layer of equal thinness. Any instrument can be conveniently coated with radium at a desired place by the method indicated.

The author demonstrated a tubular apparatus, containing an inner radium coating and designed to convey radium radiations into the lungs, for experiments on the destruction of the tubercle bacillus. The same apparatus would be useful in other connections for direct treatment of diseased tissues. It was also shown that the radium coatings are not destroyed by sterilization. The activity of a strip of celluloid with a radium coating was undiminished after vigorous boiling.

The availability of the radium coatings for many kinds of biological investigation is so obvious that nothing need be said here regarding it.

Some of the physical phenomena of muscle fatigue, with demonstration of tracings. Frederic S. Lee.

The investigation of the subject has been continued by the employment of a method by which the isotonic curves of all the contractions of an excised non-curarized muscle stimulated at regular intervals, are superimposed upon a recording surface. The differences which were previously pointed out in the mode of fatigue of the muscles of the frog, the turtle and a mammal, have been confirmed. Lohmann's work, in which a frog's gastrocnemius on being heated to a mammalian temperature shows a course of fatigue similar to that of mammalian muscle, has been repeated and found in general correct. But the turtle's coracoradialis profundus, similarly heated, continues to give its characteristic curve of fatigue.

Kaiser's method for determining the point on the isotonic curve where the contractile stress terminates, has been employed for the frog's gastrocnemius, and it has been found that as the height of the curve diminishes in the course of fatigue, the contractile stress terminates at progressively lower and lower points. The lowering of the latter does not, however, seem to keep pace with the lowering of the summit of the curve. Hence the two points seem to approach one another.

A new form of float for water or alcohol manometers, with demonstration: Haven Emerson. [By invitation.]

The float consists of an aluminium cylinder with very thin wall, supporting a writing arm of fine aluminium wire. For manometer tubing of nine thirty-seconds inch inside diameter, three sixteenths or one fourth inch light aluminium tubing about two and one half inches long is used. In the upper end is forced a solid cap of aluminium, with a small hole in the center into which the wire for the writing lever is driven. The lower end is plugged with cork. A coating of paraffin prevents leaking. The value of the float consists in its cheapness, ease of construction, slight inertia and delicacy.

Gelatin as a substitute for proteid in the food. J. R. Murlin.

In a series of experiments on dogs, the nitrogen requirement of the body was determined by fasting periods. Varying amounts of gelatin containing from one fourth to two thirds of the required nitrogen were fed, the remainder of the nitrogen being supplied in

meat proteid. The calorific requirement was estimated from Rubner's tables and was fully covered in each experiment with fats and carbohydrates. Results show an equal sparing of the body proteid with one fourth, one third and one half gelatin nitrogen, the coincident sparing of fats and carbohydrates being the same. When the coincident sparing of proteid by non-nitrogenous food is increased by feeding a larger percentage of carbohydrates and less fat, two thirds of the nitrogen requirement may be given in gelatin and perfect nitrogenous equilibrium maintained at the starvation level. The same result was obtained on man.

The reductions in the body in fever, with demonstrations: C. A. HERTER.

Dr. Herter demonstrated that elevation of the body temperature greatly accelerates the rate of reduction in the tissues. This was shown by means of an intravital infusion of methylene blue in a rabbit whose body temperature had been raised to 42° C. by the external application of heat. Simultaneously with this infusion another injection was made in a rabbit, of approximately equal weight, in which the temperature was maintained at about 39° C. Otherwise conditions in the two animals were practically the same. At the close of the infusions, the organs of the rabbit of normal temperature showed more color than those of the one in which the temperature had been elevated. The differences in the nervous system and the muscles were particularly striking.

The measurement of the reducing processes of cells in vitro, with demonstrations: C. A. HERTER.

An apparatus was demonstrated which had been devised for the purpose of measuring the reducing processes of the different kinds of cells *in vitro*. Definite quantities or organ pulp were placed in specially constructed tubes and anaerobic conditions were established by the passage of nitrous oxid gas. Definite quantities of methylene blue of known strength were then added. The rate of reduction was indicated by the disappearance of the blue color owing to the reduction of the animal cells. It was shown that *in vitro* the influence of temperature is the same as that observed in the living organism. The influence of alkali in accelerating reduction was also shown. The action of salts and various poisons is at present the subject of investigation.

Some medical applications of the naphthoquinon sodium mono-sulfonate reactions, with demonstrations: C. A. HERTER.

Dr. Herter demonstrated the reactions of this compound with anilin, various amins, nicotin, conin, piperidin, indol, skatol and pyrrol. Colored condensation products resulted. The reactions with indol, skatol and pyrrol possess unusual physiological and chemical interest and will form the subjects of future publications. The reaction with pyrrol, which is highly characteristic and should prove of special service to chemists, occurs in the cold and is evidenced by the deepening red which, on the addition of alkali, changes to purple, violet, blue and finally reddish brown. The addition of acid to the red solution obtained without alkali is followed by the development of a green and finally a brown color.

Among the biological and medical applications of these reactions, Dr. Herter mentioned the study of various aromatic compounds in the organism, the occurrence of certain intravital syntheses, the detection in the urine of organic compounds such as para amido phenol, and the development of a method of staining the bile capillaries by means of intravenous infusion of the derivatives of the naphthoquinon compound. Dr. Herter also stated that these substances facilitate the study of the relation between the chemical constitution and distribution of poisons in the body.

On the rate of absorption from intramuscular tissue, with demonstrations: S. J. MELTZER and JOHN AUER.

The authors tested a previous observation that absorption from the muscles is very much more rapid and efficient than from the subcutaneous tissue. Adrenalin, curare, morphin and fluorescin were used in the tests.

In the case of adrenalin, for example, it

was found that when quantities of about 0.5 c.c. per kilo or even less were injected *intramuscularly* they at once caused (1) marked increase of blood pressure, (2) dilation of the pupil on the side from which the superior ganglion had been removed and (3) general prostration. When the same quantities of adrenalin were injected *subcutaneously* however, they were almost invariably without appreciable effect in any of these connections, or, when similar phenomena were produced, they were much less marked and their onset was greatly delayed.

Similar differences in absorption velocity and efficiency were shown in the cases of curare, morphin and fluorescin.

WILLIAM J. GIES,
Secretary.

NORTH CAROLINA SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE regular fall meeting of the section was held on December 3, 11 A.M., in the office of the state chemist, Raleigh, N. C., with presiding officer, A. S. Wheeler, in the chair.

Preceding the presentation of papers a short business meeting was held and the following officers were elected for the ensuing year:

President—C. B. Williams, Raleigh, N. C.
Vice-president—J. E. Mills, Chapel Hill, N. C.
Secretary-treasurer—C. D. Harris, Raleigh, N. C.
Councilor—A. S. Wheeler, Chapel Hill, N. C.
Reporters—Chas. Walker, West Raleigh, N. C., and E. V. Howell, Chapel Hill, N. C.

The following papers were presented and discussed:

Some Problems in the Cellulose Field (presidential address). A. S. WHEELER, University of North Carolina, Chapel Hill, N. C. (Will be published by the section.)

The Action of Metals on Various Aqueous Solutions. G. McP. SMITH, A. & M. College, Raleigh, N. C.

Molecular Attraction. J. E. MILLS, University of North Carolina, Chapel Hill, N. C.

The article was a summary of work already published (*Journal of Physical Chemistry,* June, 1904) and of work along the same line yet to be published. An equation was deduced based upon the idea that the so-called cohesive forces between the molecules of a liquid could be entirely and quantitatively accounted for on the supposition of an attractive force between the molecules, the force varying inversely as the square of the distance apart of the molecules. The deduced equation was tested by an examination of twenty-five liquids over wide ranges of temperature and pressure. The measurements used, were, for the most part, those made by Drs. Ramsay and Young and Dr. Young. The result undoubtedly allows the conclusion to be drawn that the intramolecular forces obey a law exactly similar to the law of gravitation, *i. e.,* the attraction between the molecules of any liquid varies inversely as the square of the distance apart of the molecules, does not vary with the temperature and is a function of the number of molecules (mass) considered.

The results also point to the conclusion that the so-called molecular association, as in the case of water, is caused by this same molecular attraction and not by another force such as chemical affinity.

On Crompton's Equation for the Heat of Vaporization. J. E. MILLS, University of North Carolina, Chapel Hill, N. C.

An equation proposed by Mr. Crompton (*Proc. Chem. Soc.,* Vol. 17, 1901),

$$L = 2RT \log_e d/D$$

(L is heat of vaporization, R is the constant of the gas equation, $PV = RT$, T is the absolute temperature, d and D are the densities of liquid and vapor respectively) was examined. It was shown that the latent heats so calculated were invariably and usually very considerably too high at low temperatures where the vapor pressure is small, but at high pressures as the critical temperature of the liquid is approached the results are in excellent agreement with the true heats of vaporization. Some important results following from this equation were pointed out. The article is to be published in the *Jour. Phys. Chem.,* December, 1904.

Some Notes on the Determination of Crude Fiber. J. M. PICKEL, Department of Agriculture, Raleigh, N. C.

A Method for the Extraction of Salicylic and Benzoic Acids and Saccharine in Food Products. W. M. ALLEN, Department of Agriculture, Raleigh, N. C.

On Biot's Formula for Vapor Pressure. J. E. MILLS, University of North Carolina, Chapel Hill, N. C.

It was shown that Biot's formula for the vapor pressure of a liquid,

$$\log P = A + bd^4 + cB^t,$$

does not exactly represent the true vapor pressure of a liquid in the immediate neighborhood of the critical temperature. The article is not suitable for abstraction and will shortly be published in full.

Note on the Law of Dulong and Petit. J. E. MILLS. University of North Carolina, Chapel Hill, N. C.

Collected data for the specific heats of the metals were exhibited in the form of curves. The results show that the law of Dulong and Petit in its present form has but slight basis in fact.

On the Chemical Combination of Hydrogen and Oxygen when Subjected to the Action of Radium Radiations. CHARLES W. EDWARDS, Trinity College, Durham, N. C.

I desire to announce to the North Carolina Section of the American Chemical Society the discovery of the synthetic action of radium radiations in its chemical effects. Numerous effects have been observed and published wherein compounds have been decomposed into elements or transformed into simpler compounds. For instance, radium bromide dissolved in water produces H and O, it produces ozone in the air, and helium is produced by the radium emanation.

Certain investigations of a negative result carried out last year in England concerning the effect of ionization by ultra-violet light on gaseous mixtures led me to attempt the same problem, using radium as the ionizing agent. This I was able to do, thanks to the kindness of Dr. Bergen Davis and Dr. G. B. Pegram, of Columbia University, and of the department of physics in various ways, especially in the loan of five milligrams of pure radium bromide worth at present about $350.

The amount of chemical combination was measured by the change in volume of the gas exposed to the radiations. The saturation current was measured by the electrometer method and the following data are based on those measurements. I am now taking the current by a ballistic method and measuring volumes more accurately, so will soon have more accurate results. I will reserve the details for a later paper, but will state now a few results.

The quantity of gas converted to water was 18×10^7 c.c. per second. In one cubic centimeter there are 4×10^{19} molecules, hence the number of molecules of gas that disappeared was

$$n = 4 \times 10^{19} \times 18 \times 10^{-7} = 7.2 \times 10^{3} \text{ per sec.}$$

three molecules of the mixed gases. If $M =$ number of molecules of water formed per second

$$M = \tfrac{2}{3} \times 7.2 \times 10^{13} = 4.8 \times 10^{13}.$$

If $N =$ number of physical ions produced, then in this case $N = 7.32 \times 10^{9}$.

Hence

$$\frac{M}{N} = \frac{4.8 \times 10^{13}}{7.32 \times 10^{9}} = 6.500.$$

From this it appears that 6,500 molecules of water were formed for each ion produced by the radium radiations—a result far in excess of expectations or theoretical predictions.

After the program the visiting chemists were the guests of the resident chemists at a table d'hôte dinner at Giersch's café.

C. D. HARRIS,
Secretary.

SCIENCE CLUB OF THE UNIVERSITY OF MISSISSIPPI.

THE first meeting of the Science Club of the University of Mississippi for the current session was held September 30, Professor J. W. Johnson presenting a paper on 'The Teaching of Physics.'

At the October meeting Professor R. W.

Jones led in a discussion of the subject, 'The Training of Chemists,' reviewing a recent paper by Sir William Ramsay.

Dr. P. W. Rowland followed with a statement of his views on the treatment of the opium habit. According to his theory something is manufactured in the fluids of the body of an opium eater which acts as an antitoxin—something positive is developed which counteracts or antagonizes the morphine. These opposing forces approximate a condition of equilibrium, thus enabling the victim to take ever-increasing doses. This partial equilibrium is lost when the morphine is withheld. It was considered possible to produce an antitoxin, and it was suggested that the club undertake an investigation to this end. Dr. Rowland thought that some lower animal, say the horse, could be rendered immune to poisonous doses of opium or morphia by repeated injections of the substance, and that the serum thus obtained would probably contain the antitoxin in the case of the habitué of morphine or opium.

The next meeting of the club was held December 2. Dr. J. B. Bullitt, the leader for the evening, after some introductory remarks on immunity to drug influences, addressed himself more particularly to the closely allied subject 'Immunity from Disease.' Attention was called to the fact that the lower animals are immune to certain diseases to which the human race is subject, and *vice versa*. It was also noted that some divisions of the race enjoy immunity where others show peculiar susceptibility. Natural and artificial immunity were discussed. The history of the various theories of immunity, with a brief statement of each, was given, and special emphasis was laid on the 'side-chain' theory.

Alfred Hume,
Secretary.

DISCUSSION AND CORRESPONDENCE.

AN EXAMPLE IN NOMENCLATURE.

Mr. David White has published in the 'Smithsonian Miscellaneous Collections' (Quarterly Issue), Vol. XLVII., Pt. III., pp. 322–331, pl. xlvii, xlviii, a paper on 'The Seeds of Aneimites.' He shows that he has specimens of the foliage of that genus with seeds attached, also an abundance of detached seeds. He names the species bearing these seeds *Aneimites fertilis* n. sp. But he says that he discovered the seeds before he could be certain that they belonged to *Aneimites*, and had contemplated giving them the name *Wardia*, that he had even gone so far as to give them that name in a manuscript in preparation, but that he had postponed publication 'in the hope that further study * * * would yield * * * evidence bearing either on the internal organization of the fruits or on the structure of the fronds.' Such evidence he subsequently found and established to his satisfaction that the 'fruits' belong to the genus *Aneimites*, a supposed fossil fern, thus adding one more to the rapidly growing list of Paleozoic seed plants.

On page 323, where the species is described, he calls it "*Aneimites* (*Wardia*) *fertilis* n. sp., but in other places *Aneimites fertilis*. He, however, constantly refers to the seeds as *Wardia*, and in at least one place (p. 329) he calls them *Wardia fertilis*. He does not pretend that they belong to a different genus from *Aneimites fertilis*, and, indeed, proves that they are the same, and the specific name is the same for both combinations. What he has done is to take a name from an unpublished manuscript of his own and publish it for the first time as an exact synonym of the name that he gives to the species. The name *Wardia fertilis* is, therefore, stillborn, or at least strangled at its birth, and has no validity whatever.

Now why should he thus cumber an overburdened literature with another worthless synonym? Such a proceeding in the present state of science is a recognized crime. As Mr. Bather said in discussing a similar case some time ago, what does the scientific world care for his private excogitations over material too imperfect for publication?

But the name *Wardia* was preoccupied anyhow, for that name was given by Harvey and Hooker in 1836 to a genus of

mosses from the Cape of Good Hope,* dedicated to N. B. Ward, Esq. The genus and one species, *W. hygrometrica,* were fully described and figured. If it be said in extenuation that the work in which it occurs is somewhat difficult of access, this can not be said of Endlicher's 'Genera Plantarum,' which is in all libraries, and where (p. 1345) the genus is redescribed and is duly entered in the index. The author of this two-fold achievement is a member of the Committee on Botanical Nomenclature! LESTER F. WARD.

DELUC'S 'GEOLOGICAL LETTERS.'

TO THE EDITOR OF SCIENCE: With all due respect for the opinions of Dr. Emmons and Sir Archibald Geikie, I am unable to see why von Zittel was not scrupulously exact in his handling of facts when crediting Deluc with prior use of the term 'geology' as compared with de Saussure. The latter uses it but twice, defining it as 'la Théorie de la Terre,' in the earliest edition of his work, published in 1779. The second authorized edition of Deluc's 'Letters' (it had already been pirated) appeared also in 1779, the term 'geology' occurring in the body of the work an equal number of times (vol. I., pp. 4, 5), and again in a footnote on p. 7, where it is observed that the word 'cosmology' is more generally used in an equivalent sense.

It is worth noting that this footnote, which purports to be of identical† tenor with the first edition, scarcely justifies the assertion that Deluc 'could not venture to adopt the term geology because it was not a word in use.' More to the point is a passage where the author expressly designates the work in hand as a *treatise on geology:* 'Je vis que je faisois un Traité, et non une esquisse de Géologie.' He constantly refers to it later under the abbreviated title of 'Lettres Géologiques,'* and intitulated another of his productions 'Traité élémentaire Géologie.' It appears, therefore, that beginning with 1778, a year before de Saussure's work saw the light, and continuously thereafter, Deluc employed the term geology in its modern sense; hence he is entitled to generous consideration for having helped bring the name our science now bears into familiar use. Deluc, in pointing out the etymological propriety of 'geology' no doubt furnished a suggestion which de Saussure immediately caught at, since he twice employs the term, as Dr. Emmons has said, 'without any explanation or apology,' and alludes also to 'the geologist,' as is natural. Von Zittel seems to me to have exercised very candid judgment in this matter, and one must be a very 'strict constructionist' indeed who can deny Deluc's claims to priority.

Almost simultaneously with the authors just considered, the celebrated Werner appears to have been instrumental, to some extent, in popularizing the term geology. Werner's definition of this and cognate words is given by one of his distinguished pupils, d'Aubuisson, from whose 'Traité de Géognosie' we extract the following (vol. I., p. 2): "Werner remarque, en outre, que les noms composés de *logos*, tels que zoologie, minéralogie, etc., désignent l'universitalité de nos connaissances sur un objet; et, d'après cela, la géologie comprend, selon lui, non seulement la géognosie, mais encore la géographie, l'hydrographie, la géogenie, etc."

C. R. EASTMAN.

December 29, 1904.

UNIVERSITY REGISTRATION STATISTICS.

TO THE EDITOR OF SCIENCE: On reading the article 'University Registration Statistics' (SCIENCE, N. S., Vol. XX., No. 552, December 30, 1904), it occurred to me that it would be interesting to know the average number of students to each teacher, in the institutions mentioned. The 'Total Registration' (not including the 'Summer Sessions'), divided by

* 'Wardia: a New Genus of Mosses, discovered in Southern Africa,' by W. H. Harvey and W. J. Hooker; *Companion to the Botanical Magazine,* Vol. II., London, 1836, pp. 183–184, pl. xxv.

† The text reads as follows in the 1779 edition: "Je répète ici, ce que j'avois dit dans ma première *Preface,* sur la substitution du mot *Cosmologie* à celui de *Géologie:* * * * c'est que l'usage ordinaire a consacré le premier de ces mots, dans le sens où je l'emploie."

* Compare, for instance, his frequent correspondence in the *Journal de Physique.*

the number of officers gives the results as shown in the last vertical column of the table appended. The figures in the second and third columns are transcribed from the article referred to above.

Institution.	No. of Students.	No. of Officers.	No. of Students to One Officer.
California	3,130	330	9.48
Chicago	2,218	184	12.54
Columbia	4,056	551	7.36
Cornell	3,364	451	7.45
Harvard	4,516	534	8.45
Illinois	3,233	365	8.85
Indiana	882	72	12.25
Johns Hopkins	740	156	4.74
Leland Stanford Jr.	1,420	130	10.92
Michigan	3,667	270	13.58
Minnesota	3 671	197	18.63
Missouri	1,536	88	17.45
Nebraska	2,414	173	13.95
Northwestern	2,806	346	8.10
Ohio State	1,723	143	12.04
Pennsylvania	2,940	330	8.90
Princeton	1,385	114	12.14
Syracuse	2,419	201	12.03
Virginia	691	45	15.35
Wisconsin	2,668	243	10.97
Yale	2,995	330	9.07

William B. Schober.

Lehigh University,
January 5, 1905.

SCHOOLS OF TECHNOLOGY AND THE UNIVERSITY.

To the Editor of Science: In connection with the proposed combination of the Massachusetts Institute of Technology with Harvard University, the following authoritative statement of foreign opinion (translated from *Zeitschrift des Vereines deutscher Ingenieure* of September 24, 1904) is of interest:

At a meeting of the Union of German Engineers, held at Munich September 12, with the participation of thirty eminent representatives of technological schools and universities, as well as of other schools and of industries, the following resolutions were adopted:

1. It is not advisable, so far as can be foreseen, to attempt to meet the need of new technological schools by the addition of technological faculties to universities, but rather by the establishment of independent institutions; for the technological schools would be hindered in their independent development by attaching them to universities. This separation should not, however, impede the welcome development of intellectual good will between the two institutions. The attachment to universities would also in no way involve economies of consequence.

2. The Union of German Engineers stands now, as before, by its expression of 1886, as follows: "We declare that the German engineers have the same needs and will be subjected to the same judgment as to their general culture as the representatives of other professions based on higher scientific education." In this view we rejoice as the conviction more and more gains ground that a considerably greater significance is to be attributed than before to mathematical and natural science as a means of culture. Knowledge of these branches is becoming more and more an indispensable constituent of general education. The predominantly linguistic education now received by the majority of our gymnasium graduates does not satisfy the demands which must be made on the leading classes of our people, in particular, in respect to the increasing significance of economic questions.

Tech Graduate.

SPECIAL ARTICLES.

PROPOSED INTERNATIONAL PHONETIC CONFERENCE TO ADOPT A UNIVERSAL ALPHABET.*

I wish to call your attention to a circular recently issued by Boston University, inviting opinions on the proposal to hold an international conference for the purpose of adopting a universal alphabet. In the Roman alphabet we already have a practically universal alphabet. A comparatively slight effort will suffice to make it perfect and quite universal. Whoever has looked into the subject knows that it is perfectly practicable to introduce such modifications in the Roman alphabet as to make it perfectly phonetic and yet leave the spelling in such condition that it shall be readily legible to people who know only the Roman alphabet in its present form.

I need not dilate on the advantages to be expected from the use of an alphabet which would enable every child to read as soon as it knew the letters, and which would, furthermore, enable any one to pronounce foreign languages correctly at a glance, because their spelling,

* Read before the Comparative Philology Section of the Language Group of the Congress of Arts and Science at St. Louis, September 21, 1904.

apart from a few special sounds, would be the same as in his own language. It is easy to see how this would promote pleasant intercourse and mutual understanding among the nations, by facilitating the acquisition of foreign languages. All the leading languages would thus tend to expand and to become cosmopolitan; but most of all would this be true of English, which is more hindered in its expansion by its spelling than any other language. It is, perhaps, not too much to say that the universal alphabet will confer on the English language the patent of universality.

To prepare such an alphabet is a comparatively easy task. The real problem is how to get it accepted by the public. Scores of such alphabets exist already, but not one of them possesses sufficient authority to compel its universal use. How shall such authority be secured?

To this question the circular recently issued by Boston University seeks to obtain an answer. It invites opinions on the plan to hold an international conference for the purpose of adopting a universal alphabet to be used first of all as a key to pronunciation in all dictionaries of the leading languages. I may state at once that the replies received from the editors and publishers of the great American dictionaries are highly encouraging. They state with practical unanimity that, if a universal alphabet were drawn up by a commission composed of the foremost experts, and invested with the requisite authority by scientific bodies of high standing, they would introduce that alphabet as a key to pronunciation in future editions of dictionaries, primers, readers, grammars and language manuals as fast as practicable.

It is evident that, if the dictionaries adopt this universal alphabet, a large part of the rising generation will become familiar with it. It will be used by everybody who wishes to indicate pronunciation. It is even probable that the entire rising generation will soon grow accustomed to it, for the following reasons: Experiment has proved that children beginning with a phonetic alphabet learn to read in a few weeks and master even the ordinary spelling more rapidly than by the present method. The reason is evident. The essential part of the art of reading consists in the ability to recognize the outline of a word at a glance, without having to spell out the letters. Having in a few weeks acquired the ability to recognize words in the phonetic spelling, children will recognize them also in the traditional spelling, because the difference in the outline will in most cases not be great. We see this daily illustrated by the ease with which school-bred immigrants learn to read English, though accustomed at home to a totally different spelling. Having acquired in their own language the ability to recognize whole words at a glance, they soon begin to recognize also English words whose meaning they have learned from conversation.

When the universal alphabet has been adopted in the dictionaries, it is certain that the experiment of beginning with it in the primary schools will be made in many parts of the country, for the movement has many friends among educators. When the results of these experiments become generally known, it will not be long before all the schools begin with the universal alphabet. For some time they will doubtless use it merely as an easier method to teach the traditional spelling; but when it is found that children, after two months of schooling, are able to read any book printed in the phonetic spelling, the question will soon be raised why they should be forced to spend another year or more in learning another spelling.

It will be noted that the acceptance of the universal alphabet by the dictionaries was made subject to an if. They are willing to use this alphabet if it is presented to them invested with a sufficient degree of authority. Nothing should be neglected that can add to this authority. Hence the commission which is to prepare the universal alphabet must fulfil four conditions:

1. It should be composed of the foremost experts in phonetics.

2. They should be invested with representative power by learned bodies of the highest standing.

3. They should receive their final commissions from the various governments.

4. They should conduct their work not merely by correspondence, but should have at least one meeting, preferably several meetings, occupying an adequate length of time.

The scholars able to do the work exist; it only remains to enable them to organize. For this purpose, the circular issued by Boston University is to serve as a preliminary step. Its aim is to obtain the opinion of the learned public. Thus far it has been sent only to the members of the Philological Association, and it may be stated that out of 67 replies received up to September 16, only 4 questioned the utility of the conference, the great majority being emphatic and even enthusiastic in its advocacy. In a few weeks the circular will be sent to every university professor in the United States and Canada.

The question has several times been asked, why a conference of the English-speaking nations alone would not suffice. The answer may be gathered from what has been said above. The supreme need of the phonetic alphabet, in order to secure its adoption by the public, is authority; and of course the authority of a universal alphabet, adopted by an international commission, would far exceed that of an alphabet devised for one language only. It is desirable to secure the use of the alphabet by the largest possible number of persons at once, in order to impart to it the requisite momentum to carry it into popular use. Evidently the momentum of an international alphabet will be incomparably greater than that of a merely national alphabet. Above all, it must be remembered that the sounds of the leading European languages are for the most part nearly identical, and that all the nations are striving to adopt phonetic alphabets. If now each nation does this for itself, we shall be confronted with the dilemma that either needless differences will be permanently established between the languages, or, if there is to be identity of writing to correspond with the practical identity of sounds, certain nations will be forced to abandon their laboriously constructed systems in order to conform to the system of another nation. The obvious remedy, the reasonable, neighborly, courteous method is an agreement by the common consent of all the nations concerned, and now is the time to secure it, while as yet none of the national phonetic alphabets have found any notable degree of acceptance.

The realization of the conference is simply a matter of expense. It means that a dozen or a score of the most eminent scholars shall be enabled to devote the requisite time to it. If the replies to the circular demonstrate that the great majority of the learned public favors the plan, it seems entirely probable, in view of the importance of the subject, that the requisite funds will be forthcoming.

Robert Stein.

U. S. Geological Survey,
Washington, D. C.

Awards to the Collective Exhibit of the Land-Grant Colleges and the Experiment Stations.

The collective exhibit of the American colleges of agriculture and mechanic arts and the experiment stations at the St. Louis Exposition, illustrating special features of the instruction work of these institutions and the methods and results of the agricultural experiment stations, was awarded 27 grand prizes, 37 gold medals, 35 silver medals and 35 bronze medals, a total of 135 awards, aside from those made to individual exhibitors. The collective exhibit as a whole received a grand prize; and similar awards were made to the sections of agronomy, in charge of Mr. J. I. Schulte, of the office of experiment stations; of horticulture and forestry, in charge of Professor S. B. Green, of Minnesota; of economic entomology, in charge of Professor C. P. Gillette, of Colorado; of mining engineering, in charge of Professor S. B. Christy, of California; of architecture, in charge of Professor W. H. Lawrence, of Massachusetts; of mechanical engineering, in charge of Professor W. F. M. Goss, of Indiana; of drawing and shop practice, in charge of Professor F. P. Anderson, of Kentucky; and of technical chemistry, in charge of Dr. W. H. Walker, of Massachusetts; to the dairy laboratory, in charge of Professor E. H. Farrington, of Wisconsin; the sugar laboratory, in charge of Dr. W. C. Stubbs, of Louisiana; and the plant laboratory,

in charge of Dr. W. H. Evans, of the office of experiment stations.

Gold medals were awarded to the sections of animal husbandry (2), in charge of Dr. H. P. Armsby, of Pennsylvania, and Professor Thomas F. Hunt, of New York; of fertilizers, in charge of Dr. E. B. Voorhees, of New Jersey; of plant pathology, in charge of Mr. F. C. Stewart, of New York; of rural engineering, in charge of Dr. Elwood Mead, of the office of experiment stations; and of veterinary medicine, in charge of Dr. D. S. White, of Ohio; and to the soils laboratory, in charge of Professor M. F. Miller, of Ohio.

Awards of silver medals were made to the section of biological sciences, in charge of Dr. G. E. Stone, of Massachusetts, and that illustrating the inspection work of the stations, in charge of Director M. A. Scovell, of Kentucky; and bronze medals to the sections of home economics, in charge of Miss Maude Gilchrist, of Michigan, and of rural economy, in charge of Professor F. W. Card, of Rhode Island.

Awards were also made to institutions represented in the exhibit as follows: Grand prizes to the Alabama, Connecticut State, Illinois, Louisiana, Minnesota, Missouri (2) New York State, Pennsylvania and Wisconsin experiment stations; to the agricultural colleges of Missouri and Wisconsin universities; to the College of Mining, University of California; to the bureau of education, and to the office of experiment stations, Department of Agriculture. Gold medals to the Arizona, California, Connecticut State, Connecticut Storrs, Maine, New Jersey, New York State (3), Tennessee, Washington and Wyoming (2) Experiment Stations; to the Colleges of Agriculture at Cornell University, the universities of Illinois, of Minnesota, of Missouri and of Ohio, and Purdue University; the agricultural colleges of Michigan, North Dakota, Texas, Utah and Virginia; to the Massachusetts Institute of Technology and the engineering departments of the Mississippi, New Mexico and South Carolina Agricultural Colleges, and the Hampton Normal and Agricultural Institute. Silver medals were awarded to the Arkansas, Connecticut State, Hawaii, Kentucky, Maine, New Jersey, New Mexico, New York Cornell, North Carolina, Utah, Vermont (2) and Wisconsin (2) Experiment Stations; to Hampton Normal and Agricultural Institute; the Kansas (2), Michigan, Rhode Island and Utah agricultural colleges; and the agricultural colleges at the Universities of Maine, Minnesota, Missouri, Ohio and Wisconsin; the Massachusetts Institute of Technology, mining department of Nevada State University, department of architecture of Cornell University, Sibley College of Cornell University and Pennsylvania State College. And awards of bronze medals were made to the Connecticut state, Connecticut Storrs, Florida, Hawaii, Kentucky, Louisiana, Missouri, New York state (2) and Pennsylvania experiment stations, and the office of experiment stations; to the agricultural colleges of South Carolina (2), Iowa, Kansas, Massachusetts, Michigan and Oregon; the agricultural colleges connected with Cornell University, and the universities of Illinois, Maine, Minnesota, Missouri, Nebraska, Ohio (2), Purdue (2), Wisconsin and Wyoming; to the Massachusetts Institute of Technology, and the engineering department of the University of Tennessee.

The exhibit was made with a special appropriation from congress of $100,000, which was expended under the general supervision of the government board. Its preparation was in charge of a committee appointed by the Association of American Agricultural Colleges and Experiment Stations, to whose labors, supported by the generous collaboration of the colleges and stations, its success was due. It was by far the most comprehensive and typical exposition of the work of instruction and research at these institutions which has ever been brought together, and its location in the Palace of Education secured for the agricultural departments of the colleges and the experiment stations a recognition of their place among the great educational efforts of the nation. It impressed itself upon intelligent observers as a worthy and consistent exposition of certain features of education and

research in the relations of science to agriculture and the mechanic arts.

E. W. Allen.

Office of Experiment Stations,
U. S. Department of Agriculture.

SCIENTIFIC NOTES AND NEWS.

Professor Ernest Rutherford, of McGill University, has been appointed Silliman lecturer at Yale University for 1905. The previous Silliman lecturers have been Professor J. J. Thomson, of Cambridge University, and Professor Charles S. Sherrington, of Liverpool University.

The newly elected officers of the American Physiological Society are: *President,* Professor Wm. H. Howell, of Johns Hopkins University; *Secretary,* Professor Lafayette B. Mendel, of Yale University; *Treasurer,* Professor Walter B. Cannon, of Harvard University. Additional members of the council are Professor R. H. Chittenden and Dr. S. J. Meltzer.

At the seventh biennial convention of the Society of the Sigma Xi, held in Philadelphia, December 29, 1904, the following officers were elected: *President,* Professor Edward L. Nichols, Cornell University; *Vice-President,* Professor T. H. Macbride, Iowa State University; *Recording Secretary,* Professor William Trelease, Missouri Botanical Garden; *Corresponding Secretary,* Professor H. B. Ward, University of Nebraska; *Treasurer,* Professor L. M. Underwood, Columbia University.

The Royal Danish Geographical Society has conferred its gold medal on Captain Robert F. Scott, R.N., the leader of the recently returned Antarctic Expedition.

The council of the Geological Society of London has this year made the following awards of its medals and funds: The Wollaston medal to Mr. J. J. H. Teall, director of the Geological Survey of the United Kingdom; the Murchison medal to Mr. E. J. Dunn, director of the Geological Survey of Victoria; the Lyell medal to Dr. Hans Reusch, director of the Geological Survey of Norway; the Bigsby medal to Dr. J. W. Gregory, lately professor at Melbourne and now professor of geology in Glasgow University; the Wollaston fund to Mr. H. H. Arnold Bemrose for his researches in the geology of Derbyshire; the Murchison fund to Mr. H. L. Bowman for his mineralogical work, while the Lyell fund is divided between Mr. E. A. N. Arber, in recognition of his work in paleobotany, and Mr. Walcot Gibson for his geological work in the Midland Counties of England.

President Eliot, of Harvard University, has been elected a corresponding member of the Academy of Moral and Political Sciences of the Institute of France.

Sir Norman Lockyer has been elected a corresponding member of the St. Petersburg Academy of Sciences.

Dr. George A. Dorsey, of the Field Columbian Museum, and Dr. Alex Hrdlicka, of the U. S. National Museum, have been elected corresponding members of the Society of Anthropology of Paris.

Sir John Burdon-Sanderson, who recently retired from the regius professorship of medicine at Oxford, celebrated his seventy-sixth birthday on December 21.

Mr. John F. Crowell, director of the Buffalo Botanical Garden, will visit Panama during February and March as an agent of the New York Botanical Garden, which will undertake botanical explorations in cooperation with the engineers of the Panama Canal Commission.

Reuter's Agency is informed that Mr. J. J. Harrison has left London for Khartum on his second expedition to the Congo. He intends to travel along the west side bordering on the Nile and Ituri district. He hopes to be able to secure an okapi in the forest region. Mr. Harrison has obtained leave in Brussels to bring home some pygmies.

Associate Professor Frederick Starr, of the Department of Sociology and Anthropology, of the University of Chicago, returned on December 28 from three months in Mexico. It was his fifteenth journey to that country.

Professor Russell H. Chittenden, director of the Sheffield Scientific School of Yale University, has just announced the make-up of

the Thirty-Ninth Sheffield Lecture Course for 1905, as follows:

January 20: 'A Journey in Turkestan,' Professor William M. Davis.

January 27: 'Reconnaissance Methods of Exploration in a Mountainous District,' Mr. Howard W. DuBois, M.E.

February 3: 'Powerful Discharges of Electricity,' Professor John Trowbridge.

February 10: 'Bahaman Bird-Life, with special reference to the Nesting Habits of the Flamingo,' Mr. Frank M. Chapman.

February 17: 'The Relation of the Engineer to Society,' Colonel Henry G. Prout.

February 24: 'The Destruction of Pompeii as interpreted by the Cataclysm of Martinique,' Professor Angelo Heilprin.

March 3: 'Alchemy,' President Ira Remsen.

March 10: 'Impressions of Spanish America,' Dr. Rudolph Schwill.

March 17: 'Infectious Disease and Immunity,' Dr. Simon Flexner.

March 24: 'The Physical Constitution and Properties of the Earth,' Professor Robert S. Woodward.

THE thirty-second annual meeting of the American Public Health Association was held last week in Havana under the presidency of Dr. Carlos J. Finley.

DR. ARTHUR V. MEIGS has been elected president of the College of Physicians of Philadelphia.

THE twenty-ninth anniversary of the foundation of the Johns Hopkins University will be celebrated on February 22, when Dr. William Osler will deliver the principal address.

IN a recent issue we stated that Professor Barnard, of the Yerkes Observatory, was to spend the next few months in photographing the sun, at Mt. Wilson, Cal. The observatory is primarily for solar research, but Professor Barnard's work will be the photography of the milky way and the different nebulosities in the heavens, for the observation of which the Bruce photographic telescope is especially designed.

AT the annual meeting of the board of managers of the New York Botanical Garden, held last week, a report on behalf of the scientific directors was presented by Professor L. M. Underwood, chairman, which recommended the erection of four life-size statues on the piers at the front entrance of the museum building, as provided in the original plans of the architect. These statues are to commemorate the work of Samuel Latham Mitchell, David Hosack, John Torrey and John Strong Newberry as the pioneers of botanical science in New York city. The recommendation was approved, and the making of arrangements to carry it into effect was referred to a committee composed of Mr. Charles F. Cox, chairman; Judge Addison Brown and Professor Underwood.

PROFESSOR JAMES WEIR MASON, professor of mathematics at the College of the City of New York from 1879 to 1903, died on January 10 at the age of sixty-nine years.

THE trustees of the Elizabeth Thompson Science Fund announce that income for grants is now available. Applications should reach, before February 14, 1905, the Secretary of the Board of Trustees, Dr. C. S. Minot, Harvard Medical School, Boston, Mass., U. S. A. The trustees are disinclined, for the present, to make any grant to meet ordinary expenses of living or to purchase instruments such as are found commonly in laboratories. Decided preference will be given to applications for small amounts, and grants exceeding $300 will be made only under very exceptional circumstances.

THE U. S. Civil Service Commission announces an examination on February 15, 1905, to fill two vacancies, at $1,000 to $1,200 per annum each, in the position of hydrologic aid, Geological Survey, and vacancies as they may occur in any branch of the service requiring similar qualifications.

The New York Medical Record states that the commission appointed by Harvard University, under the terms of the bequest of $100,000 by Mrs. Caroline Brewer Croft, to study cancer has prepared a report of its labors during the past four years. This report, which is now in the hands of the printer, will, if the advance statements of its contents are correct, contain little that is new. Its

conclusions are said to be that cancer is neither hereditary nor contagious, that it is not of parasitic origin, and that excision is the only cure except in the case of certain superficial growths which may be cured by radiotherapy.

The British postmaster-general has made arrangements with the Marconi Company for the acceptance and prepayment at telegraph offices of telegrams for transmission from wireless stations on the coast to ships at sea.

President Roosevelt has sent a message to congress urging the passage of the bill, now before that body, for the reorganization of the medical corps of the army. He says he is satisfied that the medical corps is much too small for the needs of the present army, and therefore very much too small for its successful expansion in time of war.

The local chamber of commerce at Grenoble has opened an industrial museum or permanent exposition of the special products and diverse industries of this region. This is to be supplemented later by an agricultural museum and bourse to show the progress of science as applied to soil cultivation and the best implements for field work, and to facilitate business transactions on the part of farmers and cultivators.

A correspondent writes to the London *Times:* The Carnegie Dunfermline trustees have endeavored to provide secondary and technical education at cheap rates, yet of a quality equal to that supplied in the largest educational centers, and by means of bursaries to bring university education within the reach of all capable and diligent students. They have appointed a musical director, Mr. David Stephen, who superintends the arrangement of concerts and directs the study of music both in the schools and by supplementary classes. They have also charge of a gymnasium and public baths, built at a cost of between £40,000 and £50,000, especially staffed and equipped for the development of physical culture. The trustees engage lecturers of repute and award prizes for the best-kept gardens. They have acquired by purchase the old parish glebe adjoining the southeastern extremity of the Pittencrieff, and have thus foreshadowed the construction of a new approach to the glen. By arrangement with the Crown they have taken charge of the palace ruins, the pathways to which they have greatly improved, and the superintendence of Queen Margaret's Cave Oratory has been transferred to them by the town council. So far the only building contemplated by the trustees is a library with a museum, the present Carnegie library being defective as regards accommodation.

The secretary of agriculture says in his annual report that "during the past year the main building of the Weather Bureau Observatory has been completed, while the power plant, the building from which balloon ascensions and kite flights are to be made, and the magnetic building are being constructed. The physical laboratory for electrical and radioactive effects is being planned, the erection of which will take place in another year. Finally, a comprehensive physical observatory for photographing the sun directly and through the spectrum, for measuring radiation energy by actinometry and bolometry, with their allied equipment, will be required. This complex institution must grow up slowly as plans can be matured along the best modern lines. When the equipment is ready we shall make and send out apparatus for the exploring of the atmosphere to altitudes of from 3 to 10 miles. It is probable that many balloons will be simultaneously liberated from different stations so as to get records of storms and cold waves from their four quadrants. With observations from the magnetic, the electric and the solar physics observatories, opportunity for study will be given to those who believe that the cyclonic and anticyclonic whirls that constitute storms and cold waves are mainly the result of changes in the amount or intensity of some form of solar radiation. It is the purpose to make the research at Mount Weather catholic in its broadness."

The London *Times* states that the annual *conversazione* of the Royal College of Science and Royal School of Mines was held at the college in South Kensington, on December 21.

These annual social gatherings are organized by the Students' Union, of which Professor Gowland is the president, and they form a kind of reunion for old students, many of whom were present at the gathering, which, notwithstanding the fog, was attended by about 500 guests. The company included Sir Norman Lockyer, Sir Arthur Rücker, Mr. Morant, Professor Judd (the dean), Professor Tilden, Professor Perry, Professor Callendar, Professor Gowland and Mr. G. W. C. Kaye (secretary). There were many interesting exhibits in the various departments in chemistry, physics, astrophysics, mechanics, metallurgy, mining, geology and biology, under the direction of their respective professors. The Solar Physics Observatory was open by permission of Sir Norman Lockyer, and a cinematograph exhibition was given, while the college company of the Corps of Electrical Engineers showed a searchlight. Dr. W. Watson, F.R.S., delivered a lecture during the evening on 'Radium and 20th-Century Alchemy,' and this was followed by a concert.

WE learn from the London *Times* that the committee appointed by the British Association for the Advancement of Science to consider the probability of ankylostoma (miner's worm) becoming a permanent inhabitant of coal mines in the event of its introduction has presented an interim report. The committee consists of Messrs. G. H. F. Nuttall, M.D., Ph.D., F.R.S. (chairman), G. P. Bidder, M.A. (secretary), A. E. Boycott, M.D., J. S. Haldane, M.D., F.R.S., and A. E. Shipley, M.A., F.R.S. The following is the summary of the committee's report:—There are many channels by which ankylostoma might be introduced into British coal mines. The conditions found underground in these mines are such that the worm would, in many cases at any rate, probably become firmly established. In view of the expense and difficulty of eradicating the worm from any mine in which it has become established, it is of the greatest importance that preventive measures should be undertaken without delay. Complete eradication does not yet appear to have been ever accomplished. The necessary prevention is best accomplished by the provision of proper sanitary accommodation in the main roads underground and at the pit's mouth, by regulations to prevent pollution of the pit by human fæces, and by the establishment of a limited quarantine system for workpeople from infected areas, with compulsory notification of cases to the home office.

ALTHOUGH only ten years had elapsed since Messrs. Whitman Cross and R. A. F. Penrose, Jr., of the United States Geological Survey, made a careful study of the geology of the Cripple Creek district of Colorado, the people of that state were last year so strongly impressed with the economic importance of a scientific examination of the ground opened by mining operations during that period that they urgently requested a resurvey, agreeing to bear half the expense of the work. The reexamination began accordingly with a thorough revision of the topographic map of Cripple Creek by Mr. R. T. Evans, who acted under the supervision of Mr. E. M. Douglas. The study of the geology and mines of the district was undertaken jointly by Messrs. Waldemar Lindgren and Frederick Leslie Ransome, who were assisted by Mr. L. C. Graton. The examination began in June, 1903, and the field work was concluded in April, 1904. Practically every accessible mine in the district was examined in greater or less detail. A preliminary report on the work, prepared by Messrs. Lindgren and Ransome, has just been published. It is issued in advance of the final laboratory examinations and is a summary of those facts that bear upon the economic development of the region and are of immediate importance to the miners.

THE *Medical Record* states that the construction of the new government laboratory building at Manila has advanced sufficiently far to permit of its being occupied by a number of branches of the Bureau of Government Laboratories. The bureau is composed at present of the following divisions: (1) A serum laboratory at which are manufactured vaccine virus, rinderpest serum, etc. (2) A library in which are to be stored and catalogued all the scientific books in possession of the government. (3) A well-appointed chemical laboratory. (4) An entomological divi-

sion, which has already done good work in the study of the insects which were destroying the cacao plants of the islands. (5) A biological laboratory, which gives much promise for the future. (6) A botanical division. The large number of plants which remain unidentified gives this division a large field in which to work. There are a number of other branches of this bureau, but they can scarcely be dignified by the name of division, as for instance the branch which takes the photographs for all departments of the government. It has also been proposed to incorporate a division of weights and measures, the necessity for which has already been felt.

Mr. Edgar Speyer, the chairman of this fund, which carries on its work in the National Hospital for the Paralyzed and Epileptic, having been asked by the Hon. Stephen Coleridge, on behalf of the National Anti-Vivisection Society, whether the researches involve experiments on living animals, has sent the following reply:—"Dear Sir,—As you are already aware, the National Hospital is not a place licensed under the Act for experiments on living animals. I am informed, nevertheless, that your society endeavored to prevent subscriptions being sent to it on the ground that some members of the medical staff, in their private capacities, are licensed under the Act. The Nervous Diseases Research Fund is an endeavor to provide funds for research into the origin and cure of those diseases. It will be conducted in the hospital under the advice of the medical staff. That being so, your past treatment of the hospital shows that it has nothing to expect from your society in the way of support. As this removes the only *locus standi* you might otherwise have to interfere, I do not think it necessary to enter further into the subject of your letter. Yours truly, Edgar Speyer. December 14, 1904."

UNIVERSITY AND EDUCATIONAL NEWS.

It is announced that Mr. Andrew Carnegie has given $100,000 to Tufts College for the erection of a library building and $50,000 to St. Lawrence University at Canton, N. Y., for a science building.

At the convocation of the University of Chicago on December 20, President Harper announced that Mr. John D. Rockefeller had signified his willingness to contribute to the University for the year beginning July 1, 1905, the sum of $245,000 for current expenses, this being the same sum that he has contributed during the present year. Mr. Rockefeller has also contributed this year $60,000 for the enlargement of the heating plant of the university.

By the will of Mr. Henry Norris, of Philadelphia, the University of Pennsylvania, the University Hospital and Haverford College each receive $5,000.

The will of Macy S. Pope of Brookline gives $25,000 each to the Massachusetts Institute of Technology and the Washington Academy of East Machias, Me.

Mr. Michael Jenkins, of Baltimore, has given to the board of directors of the Maryland Institute a site on Mount Royal Avenue, 200 feet wide and 250 feet deep, for the erection of the building. It will be remembered that Mr. Andrew Carnegie agreed to give $263,000, equal to the assets of the institute, for a building, provided the city supplied the site.

Mr. Eugene G. Blackford has bequeathed to the Brooklyn Institute of Arts and Sciences $5,000, together with his apparatus and books on zoology.

The Rev. Albert Watson, fellow of Brasenose College, Oxford, has bequeathed £4,000 to the college.

It is said that Harvard University and the University of Berlin have practically arranged a method by which a temporary exchange of professors will occur. It is further reported that a similar arrangement has been made between the Massachusetts Institute of Technology and the Berlin Institute of Technology.

Mr. W. E. Allen, professor of biology in Epworth University, Oklahoma City, has resigned to accept a graduate fellowship in zoology at the University of Nebraska, Lincoln.